Railway Age Gazette
MECHANICAL EDITION
INCLUDING THE
AMERICAN ENGINEER
Published on the First Thursday of Every Month by the
SIMMONS-BOARDMAN PUBLISHING COMPANY
Woolworth Building, New York, N. Y.

CHICAGO: Transportation Bldg. CLEVELAND: Citizens' Bldg.
LONDON: Queen Anne's Chambers, Westminster.

Edward A. Simmons, *President* L. B. Sherman, *Vice-President*
Henry Lee, *Secretary-Treasurer*
The address of the company is the address of the officers

Roy V. Wright, *Editor*
R. E. Thayer, *Associate Editor* A. C. Loudon, *Associate Editor*
C. B. Peck, *Associate Editor*

Subscriptions, including the eight daily editions of the *Railway Age Gazette* published in June in connection with the annual conventions of the Master Car Builders' and American Railway Master Mechanics' Associations, payable in advance and postage free:

United States, Canada and Mexico.......... $2.00 a year
Foreign Countries (excepting daily editions). 3.00
Single Copy .... 20 cents

Entered at the Post Office at New York, N. Y., as mail matter of the second class.

WE GUARANTEE, that of this issue 7,000 copies were printed; that of these 7,000 copies 5,924 were mailed to regular paid subscribers, 154 were provided for counter and news companies' sales, 202 were mailed to advertisers, exchanges and correspondents, and 720 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 52,800, an average of 5,867 copies a month.

The RAILWAY AGE GAZETTE, MECHANICAL EDITION, and all other Simmons-Boardman publications are members of the Audit Bureau of Circulations.

Volume 89 September, 1915 Number 9

CONTENTS

The Apprentice Letters

When we went to press with this issue, the closing date (September 1) for the competitive letters on "How Can I Help the Apprentice Boys?" had not arrived. A large number of letters had been received, however. The best one of the letters entered in the competition will be selected by the judges in the contest and will be printed in the October number, the writer meanwhile being paid the reward of $10. Such other letters as may be suitable for publication, in whole or in part, will be printed in the same or succeeding issues and will be paid for at our usual rates. The experiment has worked out so well that we have decided to conduct a series of similar competitions in the months to come, as will be noted by announcements made elsewhere in the editorial columns. Our hearty appreciation is due to those who have helped to make the contest a success. We shall be glad to receive comments or additional suggestions on the facts which are presented in the letters when they are published.

The Car Inspector Competition

The prize competition on "How Should Car Inspectors Be Trained and Developed and What Are Their Qualifications?" which was announced on page 384 of our August issue, will close on October 1, 1915. Don't fail to study the announcement and to mail your contribution in time to reach our offices in the Woolworth building, New York, on or before that date. The best article on the basis of the practical suggestions which are made will be awarded a prize of $35. Other articles accepted for publication will be paid for at our usual rates. The car inspector's position is a most difficult one to fill. Familiarity with the interchange and loading rules requires a great amount of study and much practical experience. Many of the rules are exceedingly complex, requiring more than average intelligence correctly to interpret and apply them. The selection, training and development of men who can do this work satisfactorily has given car department officers much concern. The object of the competition is to bring out as many practical and helpful suggestions as possible.

Boiler Inspection Competition

The federal requirements for inspecting and testing locomotive boilers have made it necessary for each railroad to develop a corps of boiler inspectors to see that the requirements are fully understood and fulfilled. The position is one of great responsibility and requires practical men of much intelligence and experience. Are these men given proper facilities for performing their work? Have they plenty of room, with convenient files for sorting and keeping the necessary records, data, etc.? Is their method of working carefully planned to secure the greatest efficiency? What suggestions can you make which will help them to perform their work more effectively? To develop facts and practical suggestions along some one of these or other phases of the locomotive boiler inspector's work we will give a prize of $35 for the best article which is received at our office in the Woolworth building, New York, on or before November 1, 1915. As in all of our competitions, the judges will base their decision on the practical value of the facts and data which are brought out and the logical way in which they are presented, rather than on the composition or grammatical arrangement of the article.

Piston Valve Ring Competition

During the discussion of the methods of machining piston-valve rings at the recent convention of the General Foremen's Association, much interest was displayed by the members generally as to the various methods used by the different roads. Four types of valve rings are used, the rectangular, the L, the T and the Z-shaped rings. Each road has good reasons for using some one of these types. The proper machining of the rings is also an important matter with

respect to the efficiency with which the rings do their work, economy in operation and the effect on the life of the rings. In order to obtain definite information along these lines a prize of $10 will be given to the person sending the best letter on the subject to our offices in the Woolworth building, New York, on or before October 1. It is desired to obtain, as far as possible, data as to the service obtained from the rings, the reason for using a certain specific type, the cost and time of making the ring, as well as details concerning the actual operations of machining. Not all of these phases of the question need necessarily be considered in any one letter. They are given rather in the way of suggestions in order to bring out the best practices used under different conditions on different roads. The judges will make the award on the basis of the practical value of the information presented, but will not attempt to decide which practice is best according to the arguments which are advanced by the competitors. Articles which are not awarded the prize, but which are accepted for publication, will be paid for at our usual rates.

Locomotive Mileage Account

For every locomotive mile used by the transportation department an available locomotive mile must be created by the mechanical department. This is the basis on which a road should operate if it is desired to keep the transportation department well supplied with power. The available locomotive mileage is an account from which the transportation department draws as it moves the trains. Every locomotive as it comes from the shops is good for a certain number of miles; say, for instance, 50,000. If the transportation departmen consumes 500,000 locomotive miles in one month then ten of these locomotives should have been turned out of the shops during that month to maintain the proper mileage account balance. When new locomotives are purchased there are just so many locomotive miles to be added to the account and, conversely, when the locomotives are removed from service the mileage account becomes reduced. Those engines that are in service should be inspected each month with a view to determining the amount of mileage they still have available, the mileage they have already made and their present condition being considered. By doing this the head of the mechanical department knows very nearly what available mileage he has and if retrenchments are desired, just how far he can cut down his forces and still provide the transportation department with the mileage it will require. On a large road this system should apply as a unit to each division, the passenger and freight locomotives being considered separately. If still greater refinement is desired the locomotive tractive power miles could be ascertained.

Freight Car Inspection

With another bumper grain crop in sight the car department is called upon to prepare the equipment for its transportation. In doing this too much care cannot be exercised in providing grain-tight cars. Defective equipment causes a large percentage of the loss and damage claims. For the last five years there has been an average of 69 cars a day entering Chicago with grain leakage defects. For the six months ending June 30, 1914, the railways reported to the American Railway Association a loss of $600,000 for grain due to defective equipment.

By careful repairs and rigid inspection the car department can do its part in reducing these excessive claims. The cars to be loaded with grain should be made grain-leakage proof and rain tight. The front, top and rear of the car doors should be so coopered that no moisture can penetrate into the car. The sheathing should be carefully inspected. About 65 to 70 per cent of the grain leakage defects are chargeable to the sheathing; the flooring is responsible for the rest and it, too, should not be neglected. A leaking roof on a grain car is worse than no roof at all, for without a roof the grain would not be shipped in the car. The system of testing roofs as described on page 399 of our August issue has given exceedingly good results. There are many other details that must be carefully watched if the grain leakage proof and rain-tight cars are to carry the bumper crop successfully; a small defect will eat up the profits derived from the carrying of this grain at a very rapid rate.

Of Interest to Car Men

When we proposed a few years ago regularly to devote a certain proportion of the pages of this journal to the interests of the car department some of our good friends laughed at us and said that the scheme "wouldn't work." True, they said, there is lots of good material in that department which ought to be dug up and published, but the car men will not take a sufficient amount of interest in it to make the venture really worth while; moreover, you will have a strenuous time in filling up the allotted number of pages each month.

It may be interesting to know just what has been the result of this innovation. Since January, 1913, when the scheme was first tried, the car department has been well represented in each issue. For instance, in 1913 there were 146 pages and in 1914, 142 pages of strictly car department material in the Car Department Section. This does not include the representation of that department in the editorial comments, letters to the editor, shop practice articles and new devices—a representation which was not by any means small; nor does it include the 128 pages in the four *Daily Railway Age Gazettes* issued during the Master Car Builders' Convention in 1913 and the 103 pages in the *Daily* for the M. C. B. Convention in 1914, these issues being furnished to all *Mechanical Edition* subscribers. Equally as good a record has been made thus far during the current year. So much for material.

How about the interest shown by car department officers and foremen? Our success, as indicated by a study of the subscription list, has been equally as great as in the securing of material. Even at that, however, we are not satisfied. Two things more we want to do. First, we would like to still further enlarge the car department section, and, secondly, we plan to improve its quality, or possibly we might better say to give more attention to certain classes of material. To be perfectly frank, it is comparatively easy to secure good articles on car design and construction and concerning certain of the broader car department problems. It is difficult, however, to secure certain classes of articles which go thoroughly into the practical details and methods followed by that department. Don't misunderstand this statement. There is a lot of such material available but not up to the standard or grade that we wish to present to our readers, who represent the most active and ambitious men in the department. We are going to demonstrate, however, that such material can be obtained and regularly presented. One way in which this will be done will be by a series of prize competitions, the first one of which was announced in the August issue and is commented on elsewhere in these columns. We bespeak your earnest and hearty co-operation in this movement. From such results as are already apparent we know it will prove a big success.

Improved Locomotive Design

"As the size and power of the locomotive is increased, the moving parts per unit of work to be done need not be increased in weight. On the contrary, their weight per unit of work done may be reduced. Light parts do not necessarily mean weak parts, but may mean stronger parts." These sentences sum up the thought which H. A. F. Campbell wished to develop in his series of articles on "Reciprocating and Revolving Parts," which has appeared in the *Mechanical Edition* during the past six months. The first three of these articles published in the March, April and May issues concerned improvements which have been made in lightening the

revolving and reciprocating parts on American locomotives, both by improved design and the use of alloy and heat treated carbon steels. The last two installments, one in the August issue and the other in another part of this issue, concern similar developments on British locomotives. Mr. Campbell is to be congratulated on the thorough and complete way in which he has gone into this subject, which promises to prove one of the important developments in locomotive design that will be brought about in the next few years.

Never has a difficult and complicated technical development in the locomotive field been discussed in a more thorough manner. That this has been appreciated is indicated by the fact that the Committee on Counterbalancing for the Master Mechanics' Association, which made one of the most effective reports at the June convention, made use of considerable data taken from Mr. Campbell's articles, and publicly expressed its appreciation. The committee, near the end of its report, concluded that "the secret of proper counterbalancing for any class of locomotive in any service is to reduce the weight of the reciprocating parts as far as possible. * * * Special designs of piston heads, crossheads, hollow piston rods and the use of high-grade materials, including heat-treated carbon and alloy steel, aluminum, etc., make it possible to construct very light parts, the expense of which will be many times justified by the consequent saving in repairs to equipment and track, as well as the saving due to the increase in tractive power of the locomotives."

Quality and Shop Output

Great stress is generally laid on the importance of a high shop output, the common basis of measurement being the number of locomotives a month which can be repaired in a given shop. The ability of a foreman to increase the output of a shop is very commonly used as an indication of his value as a mechanical department officer. No doubt this is a reasonably good method of arriving at an estimate of a man's ability; we do not question this, but we do question the advisability of using it as the only basis for arriving at such an estimate. Quantity is desirable and even essential in shop output. Economy demands that locomotives spend as large a proportion of the time as possible in earning money, which means that they must spend as little time as possible undergoing repairs. But there is more to the repair question than the heavy repairs made in the back shop. Most locomotive repair work is done in engine houses and it is at this point that the effect of laying too much stress on general repair shop output or quantity with a neglect of the quality of the work done makes itself most directly felt.

We do not wish to be understood as advocating a reduction in shop output, but we do believe that there are many shops in this country which are rated entirely on the number of locomotives turned out per month in determining the output, when the railway company would be money in pocket if the output were reduced as far as numbers are concerned and steps taken to materially improve the work turned out. There are railways that are doing heavy repair work in engine houses—work that should by rights be done in the general shop—simply because the general shops are required to do so many general repairs per month and the quality of the work is given but secondary consideration. We have known general foremen and shop superintendents to purposely let work get by in a partially completed condition or hurry it through at the expense of the workmanship in order to keep up the record of shop output. We do not believe there are many such men, but there is a tendency in a great many cases to overlook little things or to shirk inspection if the doing of these things thoroughly is likely to delay an engine in getting out of the shop. But if the little things are not done in the general shop they will have to be done in the engine house and they may develop into larger things that will compel the return of the engine to the general repair shop long before it has made its full mileage. These are matters to which sufficient consideration is not given in the wild rush toward increased shop output on the number of locomotives basis, but they have their bearing on not only the cost of maintaining locomotives but on the cost of conducting transportation. This is a matter which demands serious attention from higher railway officers as well as shop superintendents and foremen. The maximum possible output of any shop is desirable provided it can be accompanied by the highest quality of workmanship. Such a combination should be the end toward which railway mechanical men work rather than quantity in shop output alone. Quantity without quality will invariably result in increased maintenance charges and decreased mileage between shoppings; quantity and quality combined will tend toward economy in locomtive maintenance and train movement.

NEW BOOKS

Practical Mechanics and Allied Subjects. By Joseph W. L. Hale, S.B., E.E., associate professor of engineering, Pennsylvania State College, 228 pages, 4½ in. by 7 in. Illustrated. Bound in cloth. Published by the McGraw-Hill Book Company, Inc., 239 West 39th Street, New York. Price, $1.00 net.

The author of this book has for several years been detailed as supervisor of apprentice schools on the Pennsylvania lines east of Pittsburgh and Erie, and his purpose in preparing this book was to meet the demand of apprentice schools for a text dealing directly with the problems arising in the mechanical trades. Very little has been published which is especially adapted to the needs of trade schools generally and more particularly to the railroad apprentice school, and with the present tendency toward the growth of such institutions the need of books such as the present volume is rapidly increasing.

The material in this volume is presented in 20 chapters. A glance at the contents gives the impression of a rather heterogeneous collection of subjects, some of which the pure mechanics and others purely shop problems with very little relation to the science involved. Each chapter, however, deals with one subject and covers it completely, so that the order of presentation may be readily altered. The foregoing points will be understood by noting the titles of the first eight chapters: Chapter I, Forces; Chapter II, Gravitation, Center of Gravity; Chapter III, Density and Specific Gravity; Chapter IV, Screw Threads; Chapter V, Calculation of Levers; Chapter VI, Pulleys (Block and Tackle); Chapter VII, The Inclined Plane and Wedge, the Screw Jack; Chapter VIII, Gears, Lathe Gearing. Other subjects of a practical nature which are treated are belts and pulleys, cutting speeds of machine tools, calculation of belting, etc. These are interspersed with chapters on motion, volume and pressure of gases, work and power, heat, logarithms, the measurement of right triangles and the measurement of oblique triangles. The two concluding chapters of the book deal with electricity and the strength of materials respectively, each being a brief elementary treatise on its respective subject. The arrangement of the material, while apparently of a haphazard nature, is undoubtedly good for the purpose intended as the chapters dealing with the abstract subjects are interspersed with those dealing with problems of immediate application.

Proceedings of the Air Brake Association. Compiled and published by F. N. Nellis, secretary, Boston, Mass. 296 pages, 6 in. by 8½ in. Bound in leather.

This contains the report of the twenty-second annual convention of the Air-Brake Association, which was held in Chicago last May. It includes committee reports on the "Accumulation of Moisture and Its Elimination From Trains and Yard Testing Plants;" "Operation of the Pneumatic Signal;" "One Hundred Per Cent Operative Brakes in Freight Service;" "Hand Brakes for Heavy Passenger Cars," and "Revision of Recommended Practice."

Communications

ENGINE FAILURES

New York.

To the Editor:

I have been greatly interested in the editorial in your August issue on "Prevention of Engine Failures," in which you say that the engine house is often unjustly charged with the responsibility for such failures. I agree with you, but will go still further. In many cases the responsibility is absolutely up to the supervising officers, although they do not realize it and would be seriously offended if so charged.

If a part is wrongly designed and constructed, and causes frequent failures, those in charge should have a check on it and see that improvements are made in the design and that the construction is changed as the engines go through the back shop for general repairs. The same is true of inefficient methods of operation and of man failures. The cost of engine failures is so great, direct and indirect, that each case should be thoroughly investigated and the blame properly placed. Then, construction methods should be devised to prevent similiar failures in the future. This does not mean that a simple investigation on the part of the local officials will suffice. Each failure should be considered by a board of important mechanical and operating officers—and it will not be a bad idea to have the storekeeper sit in with them on some roads. In this way the responsibility cannot be shifted back and forth from one department to another. The time of such officers is, of course, valuable, and some provision must be made to have the reports completed and containing all the facts and evidence before they are presented to the board or committee.

After all, is it not true that the greater proportion of engine failures are "man failures"—an evidence of lack of proper supervision?

Engineer.

SAVING COAL

Atlantic City, N. J.

To the Editor:

As an enginehouse foreman at the outlying end of a division, I have had some interesting experiences in connection with coal economy during the past year. To begin with, the superintendent of the division made some inquiries as to the necessity of cleaning the fire on the engine of a freight train having a short turn-around run. What he said convinced me that I would be backed up in any point that was well taken, and I acted accordingly.

This division is about 60 miles long and we have trains coming to us from other devisions, making one-way runs of 72 and 142 miles, respectively. There is a summer and winter schedule and at the time referred to we only had one short turn-around passenger run on the winter schedule besides the freight run mentioned. The no fire cleaning rule was applied to this passenger engine. The engineman and fireman immediately said they would not be responsible for any steam failures on the return trip. They did not have any and during the entire winter the fire of this engine was not cleaned at this point. When the summer schedule went into effect the following year we did not clean the fires on any engines having two hours or less for a turn around. This resulted in a saving of 520 fires cleaned for the summer season alone. The lowest estimate that can be placed on the coal used when a fire is cleaned is about 250 lb. more than when the fire is not cleaned. This shows a saving of 80,000 lb. for the season of about three months.

There was another matter I had noticed, but had never taken any action on: this was the taking of coal. Practically every engine arriving here was taking coal and this in spite of the fact that out of a tender having a 25,000-lb. coal capacity only about 8,000 lb. or 9,000 lb. had been used. The hostlers were therefore instructed not to coal engines arriving on trains on the 60 and 72-mile runs unless they were personally ordered to do so. The enginemen and firemen when they found out about this order started in to put up every argument in their power; they would not be responsible for low steam; they would not be responsible if they ran out of coal; I exceeded my authority in issuing such orders. But the principal point and the one on which they felt that they were in the right was that the coal was not within reach of the fireman as required by the firemen's regulations. The firemen's regulations do not state or define when the coal is not within reach of the fireman and if we take two engines each starting out with a tank full of coal, one on a 60-mile run and one on the 142-mile run, it is obvious that the coal on the engine making the 60-mile run must still be within reach of the fireman at the end of the trip, or it would be necessary to put another man on the engine making the 142-mile run to shovel the coal down for the fireman. Acting on this line of reasoning, the firemen were told to go as far as they liked in the matter. We are still following this practice after it has been in effect a year. The first full month that this order was in effect was May, 1914, and with 87 less engines handled for that month as compared with the month of April, there was a saving of 2,050,000 lb. of coal loaded on tenders of locomotives. For the following four months which represents the period when our heaviest business is done there was a difference of 10,966,300 lb. less coal loaded in 1914 than during the same four months of 1913, the number of engines handled being practically the same.

It must be admitted that this does not represent that much less coal burned—it may not show any saving in that way—but it does show a big saving in freight due to hauling the coal at least 60 miles further away from the mine, and then hauling the empty cars back again. The company had started on a coal-saving campaign and shortly after issuing the order about loading coal on tenders a notice was posted that the firemen would not be permitted to start working on the fires of locomotives until one hour of train leaving time. The engines were supposed to leave the enginehouse 30 minutes before train leaving time, and this gave them 30 minutes to prepare the fire. As only bituminous coal was being used and as during my enginehouse experience we have frequently had to build new fires and have the engines ready to leave with trains in less tim than that, I felt sure that this could be done without causing any trouble.

The firemen, however, protested vigorously, and so did some of the enginemen, that the fire could not be prepared properly for the kind of service they were in. It had been the practice for the fireman to start to push down the fire about two hours before train time and then shovel coal and blow the fire so he could start out with a heavy coked fire. During this time both safety valves would blow off most of the time, the black smoke would roll out and they were really making a dirty fire to start with. However, the firemen are an inconsistent bunch; they pay a committee to have them relieved of cleaning off the seat box that they sit on and the cab windows that they look through, but then they want to fight because they were not permitted to shovel coal one hour longer than was necessary. This order, however, was lived up to and caused no trouble, and if the company wanted the men to go back to their old way of working no doubt some of them would now want to put in a time card for overtime.

The saving in coal effected by this is rather difficult to estimate, but should amount to at least 100 lb. per engine. The same economies can probably be effected at other points similarly situated.

Charles Maier.

Power Required to Raise Water.—The power required to raise water may be approximated by multiplying the gallons per minute by the elevation in feet and dividing by 3300.—*Power.*

Reciprocating and Revolving Parts

Discussion of British Practice, Including the London, Brighton and South Coast and the Midland

BY H. A. F. CAMPBELL*

This is the fifth and concluding article in this series; the first three considered American practice (March issue, page 109; April, page 163, and May, page 215) and the fourth (August issue, page 390) discussed British practice.

The London, Brighton & South Coast outside-cylinder Baltic

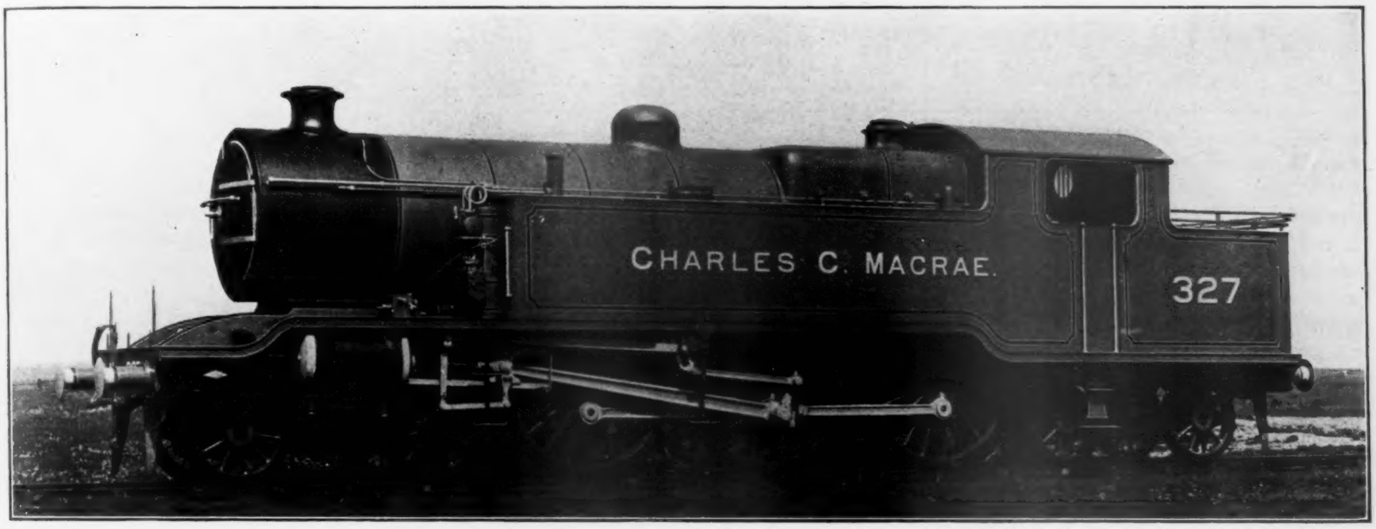


Fig. 37—London, Brighton & South Coast 4-6-4 Tank Locomotive

(4-6-4) type tank locomotive is shown in Fig. 37. This engine has 22 in. by 28 in. cylinders; a boiler pressure of 170 lb. per sq. in. (superheated steam), and 81 in. diameter driving wheels. The main and side rods are shown in Figs. 38 and 40. The bearing pressures on the pins are shown in Table XIV. The stresses at the different sections of the rods have been marked on the drawings.

The main crank pin is shown in Fig. 39. This style of pin is often used in England. By making the main rod and side rod pin eccentric, the throw of the side rod is reduced from a 28 in. stroke to a 26½ in. stroke. This may seem like a

*Baldwin Locomotive Works, Philadelphia, Pa.

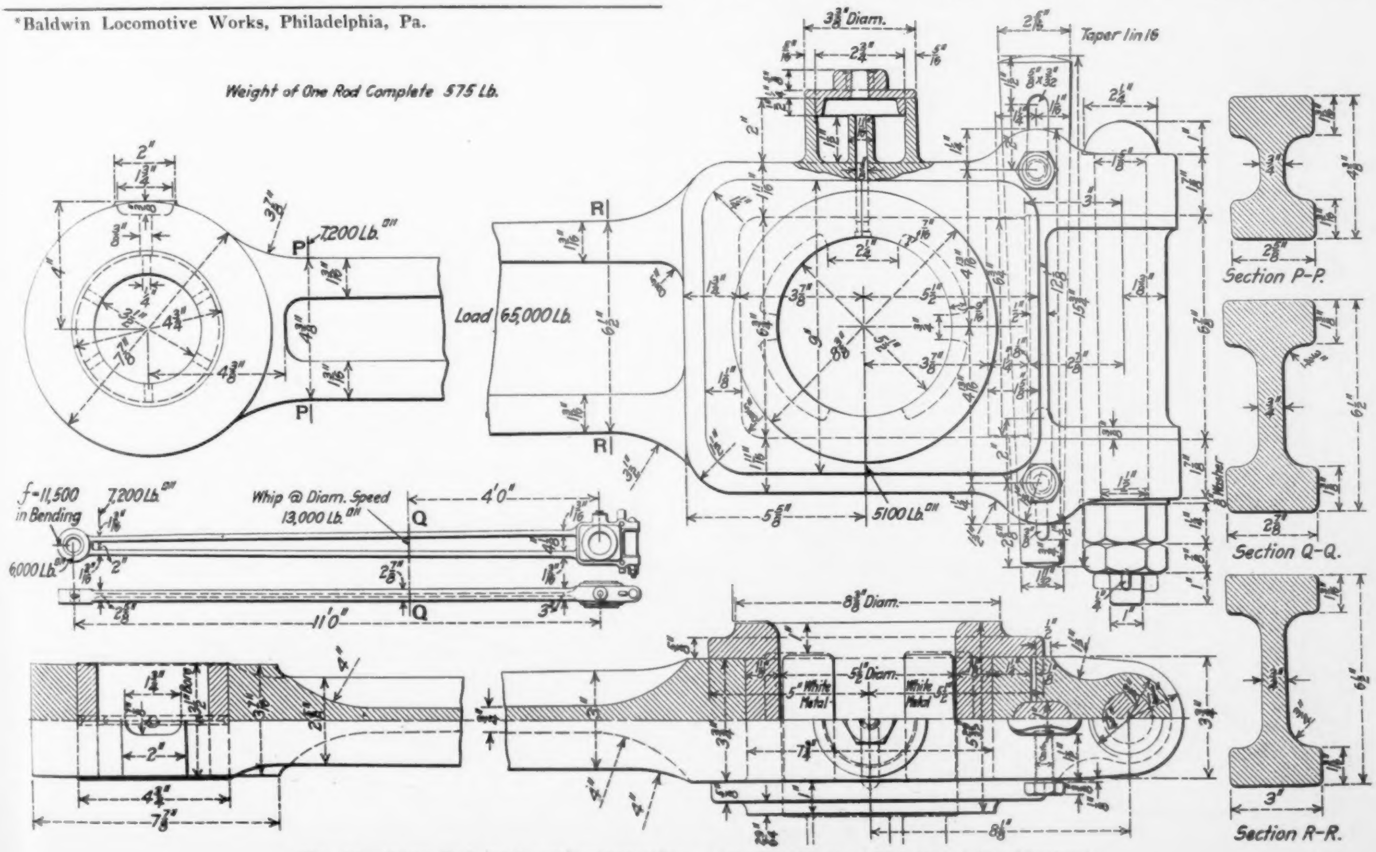


Fig. 38—Main Rod of London, Brighton & South Coast 4-6-4 Type Locomotive

TABLE XIV—BEARING PRESSURE ON PINS OF LONDON, BRIGHTON & SOUTH COAST 4-6-4 TYPE LOCOMOTIVE

Location of pin	Size	Load, lb.	Bearing pressure, lb. per sq. in.
Crosshead	3½ in. x 3½ in.	65,000	5,300
Main	5½ in. x 6 in.	65,000	1,970
Front	5 in. x 3¼ in.	21,700	1,220
Main (side rod)	7 in. x 3½ in.	43,400	1,770
Back	5 in. x 3⅜ in.	21,700	1,220
Knuckle	2¾ in. x 1¾ in.	45,500	9,480

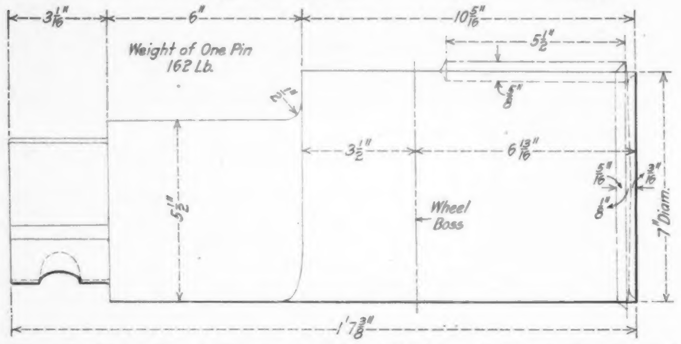


Fig. 39—Main Crank Pin for London, Brighton & South Coast 4-6-4 Type Locomotive

small detail, but it is attention to just such details that helps to reduce unnecessary weight. The fiber stress on this pin in bending is low—only 9,600 lb. per sq. in. The piston-rod and crosshead are shown in Figs. 42 and 43, and the stresses are given in Table XV.

TABLE XV—STRESSES IN CROSSHEAD AND PISTON ROD OF LONDON, BRIGHTON & SOUTH COAST 4-6-4 TYPE LOCOMOTIVE

Section and kind of stress.	Amount of stress, lb. per sq. in.
Shear on key	10,600
Tension in rod through keyway	10,700
Tension in neck of crosshead through keyway	3,850
Crushing of key on the rod	20,100
Crushing of key on the crosshead	27,500
Bearing pressure, pin on crosshead	5,600
Compression in main shank of rod	7,830

The head is made of cast steel, is of the flat plate type and is shown in Fig. 41. The valve motion parts on European engines are usually very light, and the parts of this particular engine are a good example of their practice. It is not intended to analyze them in detail, but the design is clearly shown in Figs. 44, 45, 46, 48, 49, 51 and 52.

The Somerset & Dorset Joint Railway (Midland Railway) outside-cylinder 2-8-0 type locomotive is shown in Fig. 47. This engine has cylinders 21 in. by 28 in.; a boiler pressure

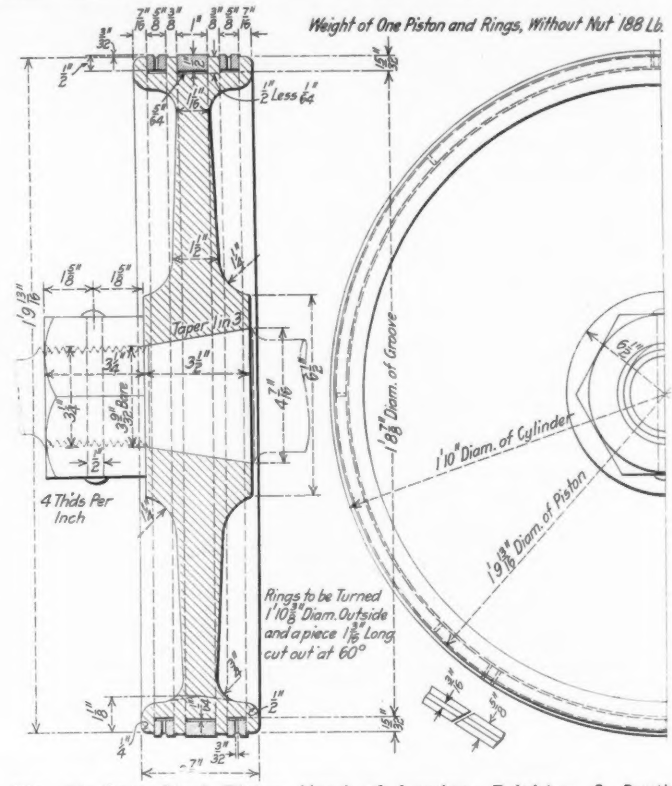


Fig. 41—Cast Steel Piston Head of London, Brighton & South Coast 4-6-4 Type Locomotive

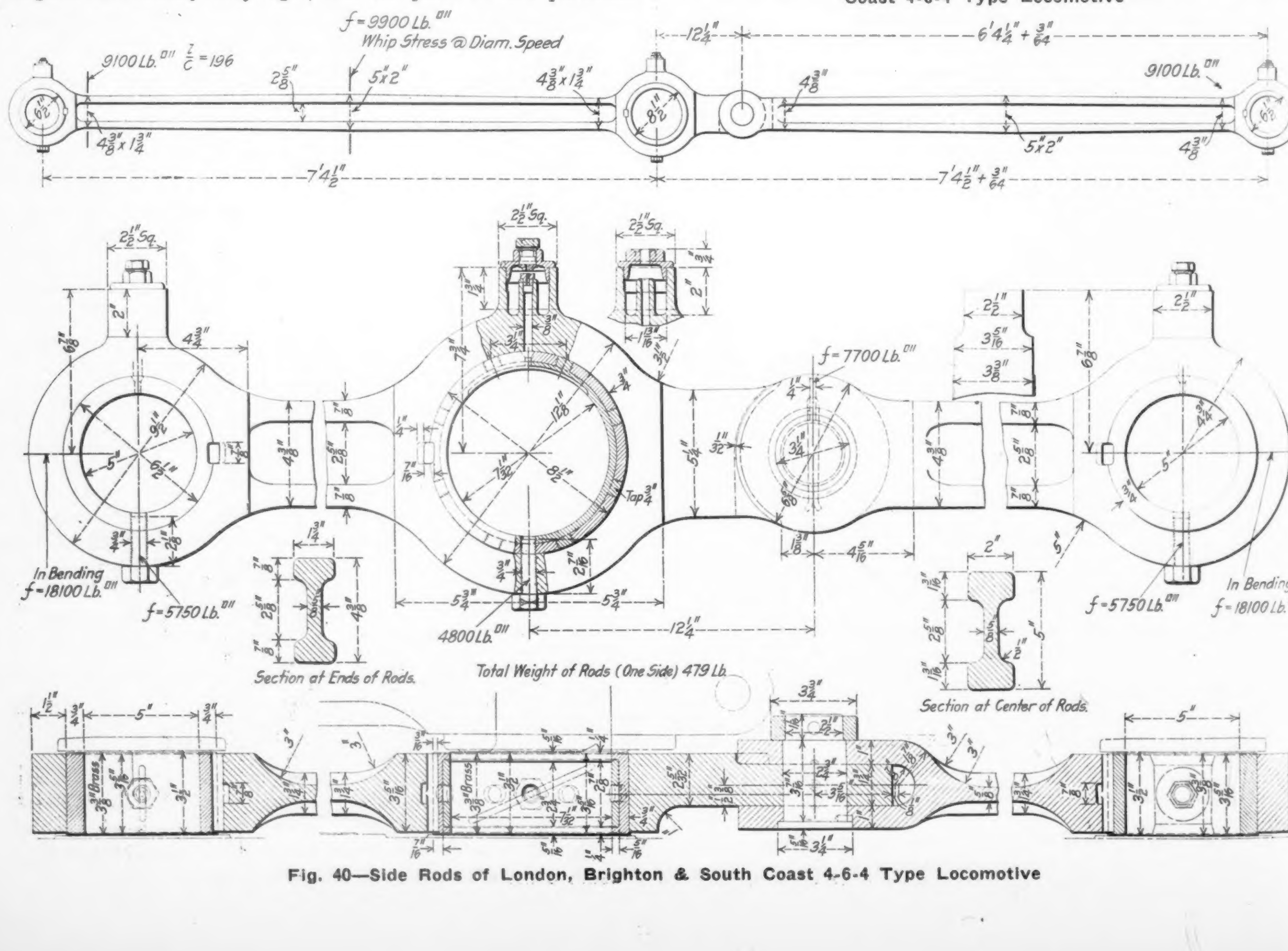


Fig. 40—Side Rods of London, Brighton & South Coast 4-6-4 Type Locomotive

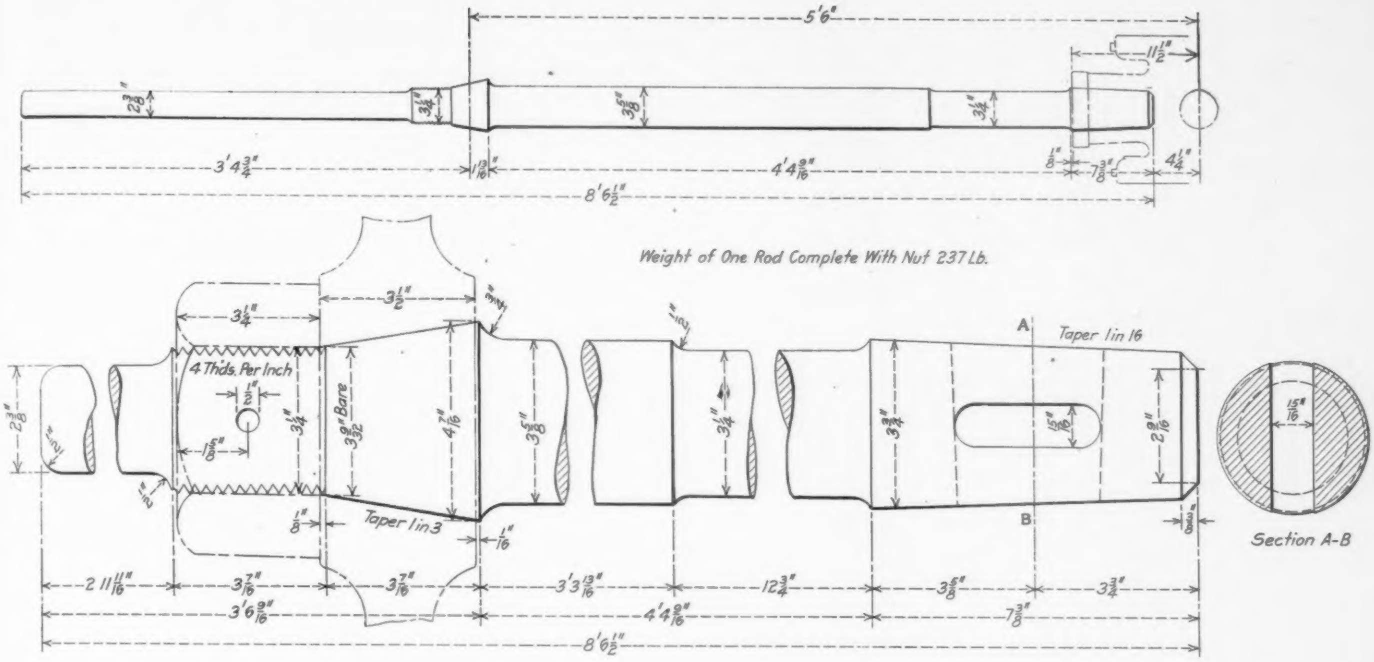


Fig. 42—Piston Rod of London, Brighton & South Coast 4-6-4 Type Locomotive

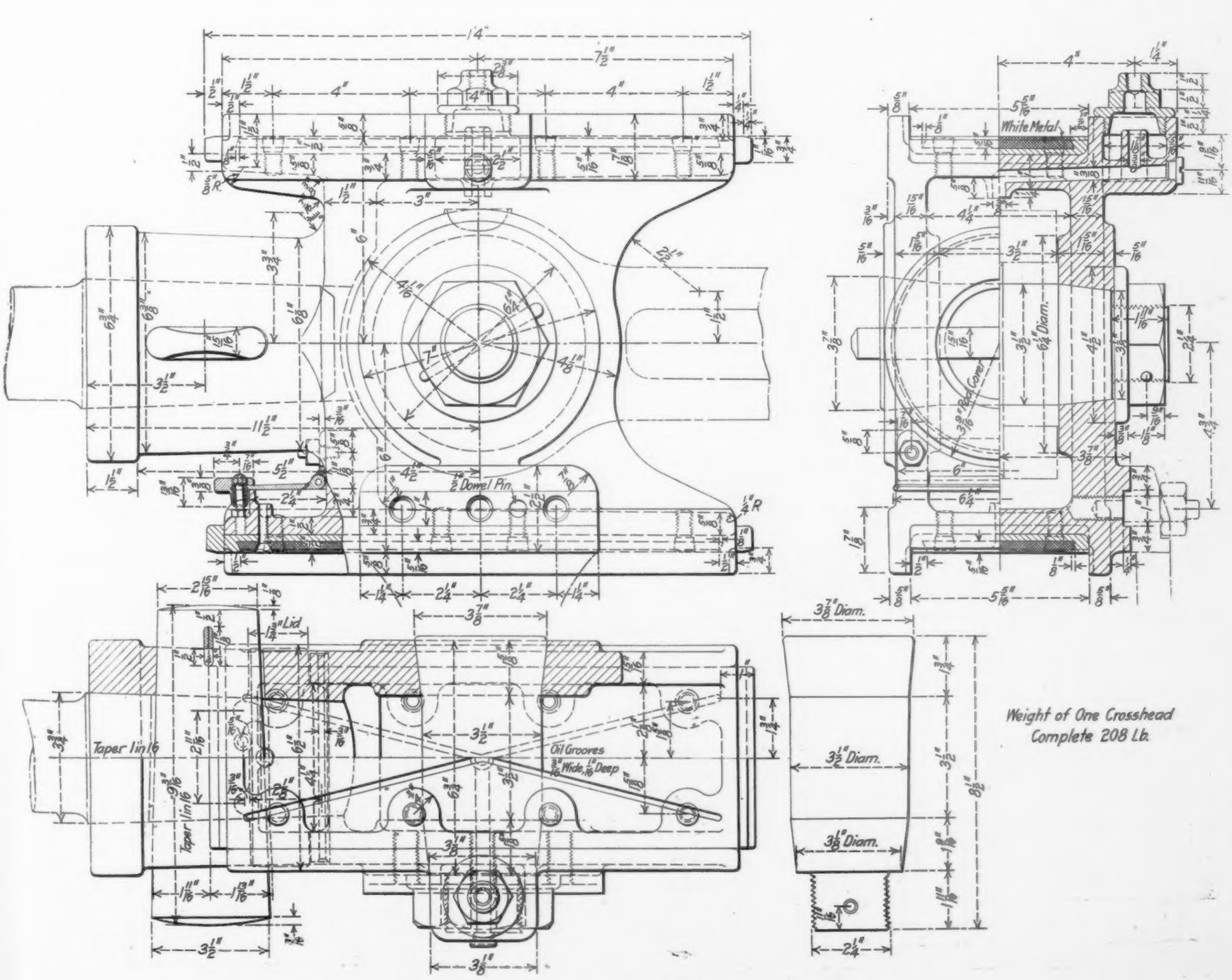


Fig. 43—Crosshead of London, Brighton & South Coast 4-6-4 Type Locomotive

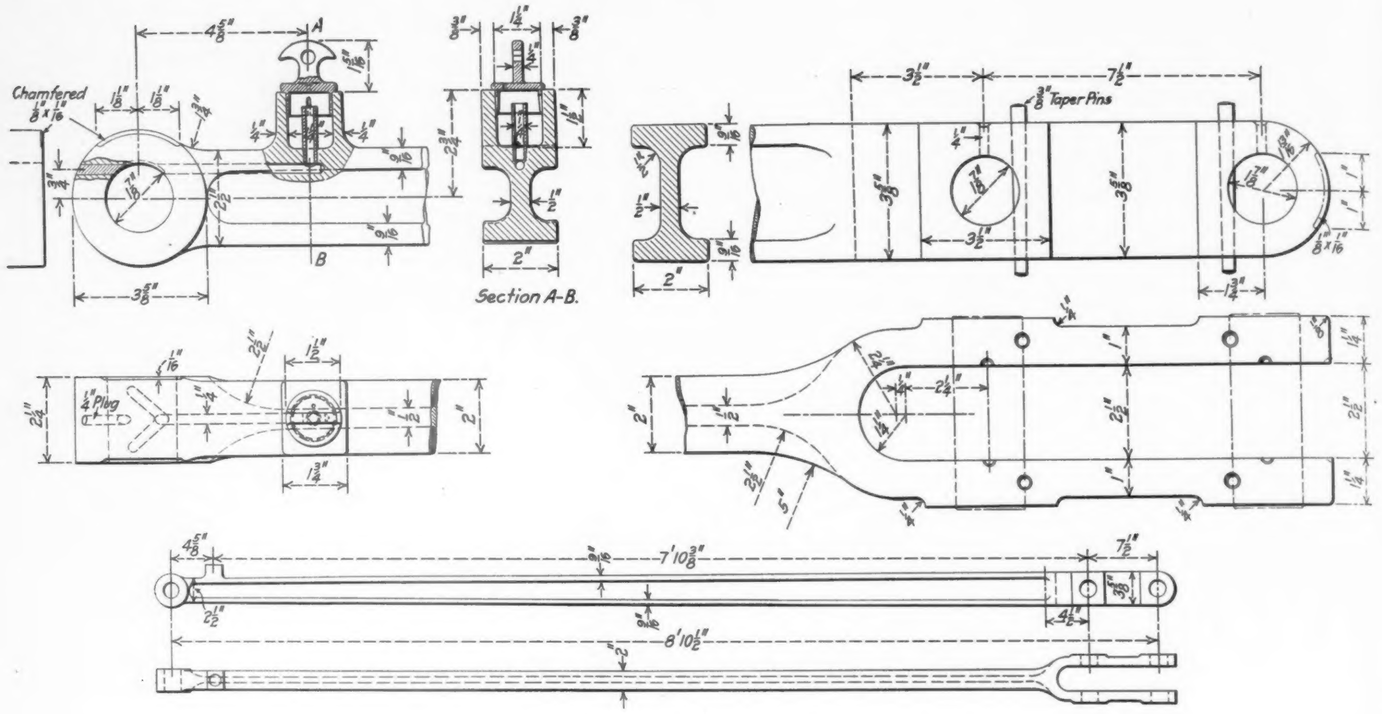


Fig. 44—Radius Rod of London, Brighton & South Coast 4-6-4 Type Locomotive

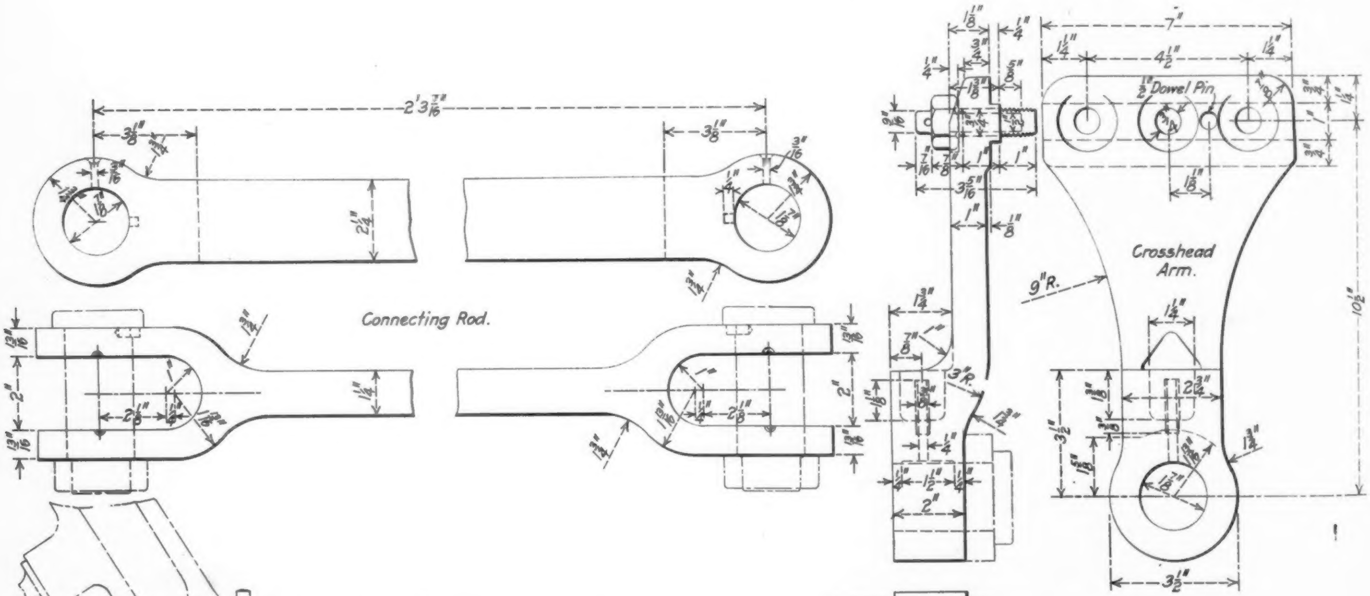


Fig. 45—Union Link, Crosshead Arm, and Combination Lever for 4-6-4 Type Locomotive

of 190 lb. per sq. in. (superheated steam), and driving wheels 55½ in. in diameter.

The main rod and side rods are shown in Figs. 50, 53 and 54, and the bearing pressures on the pins are given in Table XVI. The stresses at the different sections have been noted on the drawings. Open-hearth acid Siemens-Martin steel with an ultimate strength of 72,000 to 83,000 lb. per sq. in. is used for these rods.

TABLE XVI—BEARING PRESSURE ON PINS OF SOMERSET & DORSET JOINT RAILWAY (MIDLAND) 2-8-0 TYPE LOCOMOTIVE

Location of pin	Size	Load, lb.	Bearing pressure, lb. per sq. in.
Crosshead	3¼ in. x 3¼ in.	65,800	6,200
Main	6 in. x 5¼ in.	65,800	2,090
Front	4 in. x 3⅞ in.	16,450	1,060
Intermediate	5 in. x 3⅞ in.	16,450	845
Main (side)	6½ in. x 4¾ in.	49,350	1,600
Back	4 in. x 3⅞ in.	16,450	1,060
Knuckle	2½ in. x 2 in.	39,500	7,900

The main rod complete weighs only 500 lb. A big saving in weight has been obtained by using the solid end type of main stub. The proportions of the I-section have been carefully worked out and are an example of the type of I-section that the Baldwin Locomotive Works has used for some years: The stress of 8,800 lb. at the neck of the rod for $\frac{l}{\rho} = 181$ must be considered high.

The crosshead and piston-rod are shown in Figs. 55 and 56 and the stresses are given in Table XVII. The piston rod is made of Siemens-Martin acid open-hearth steel and has an ultimate strength varying from 94,000 lb. per sq. in. with an elongation of 15 per cent in 3 in. to 107,000 lb. per sq. in. with an elongation of 12 per cent in 3 in.

The crosshead, Fig. 55, is made of cast steel of an ultimate

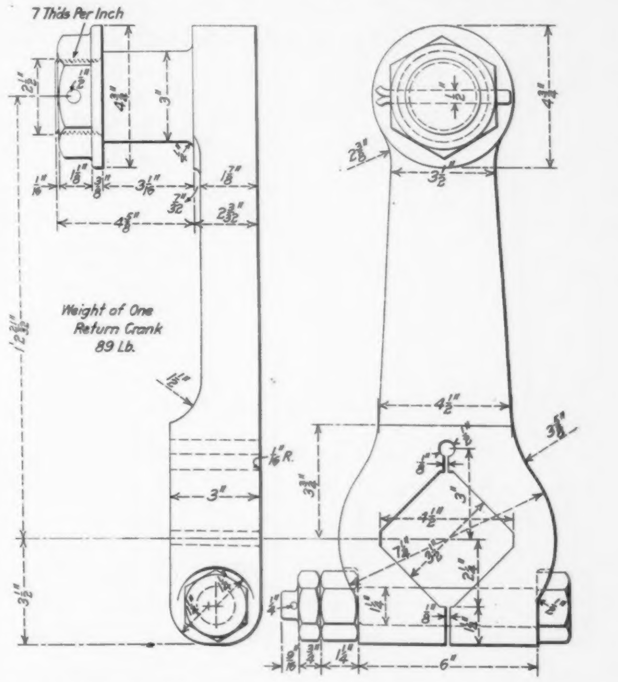


Fig. 48—Valve Motion Return Crank for 4-6-4 Type Locomotive

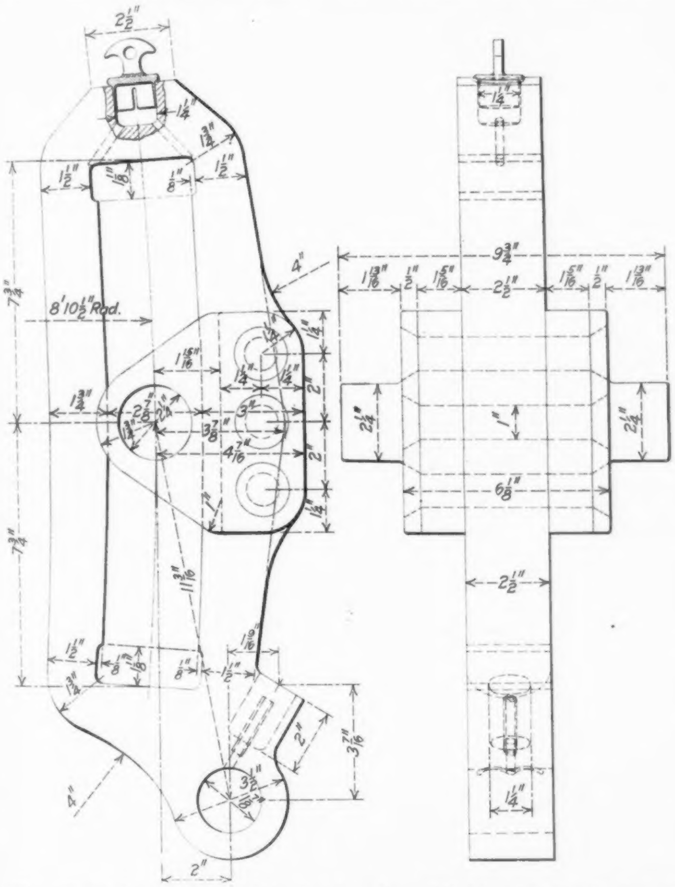


Fig. 46—Valve Motion Link for London, Brighton & South Coast 4-6-4 Type Locomotive

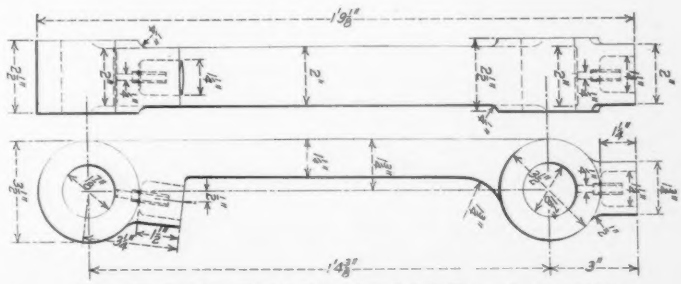


Fig. 49—Radius Rod Lifter for 4-6-4 Type Locomotive

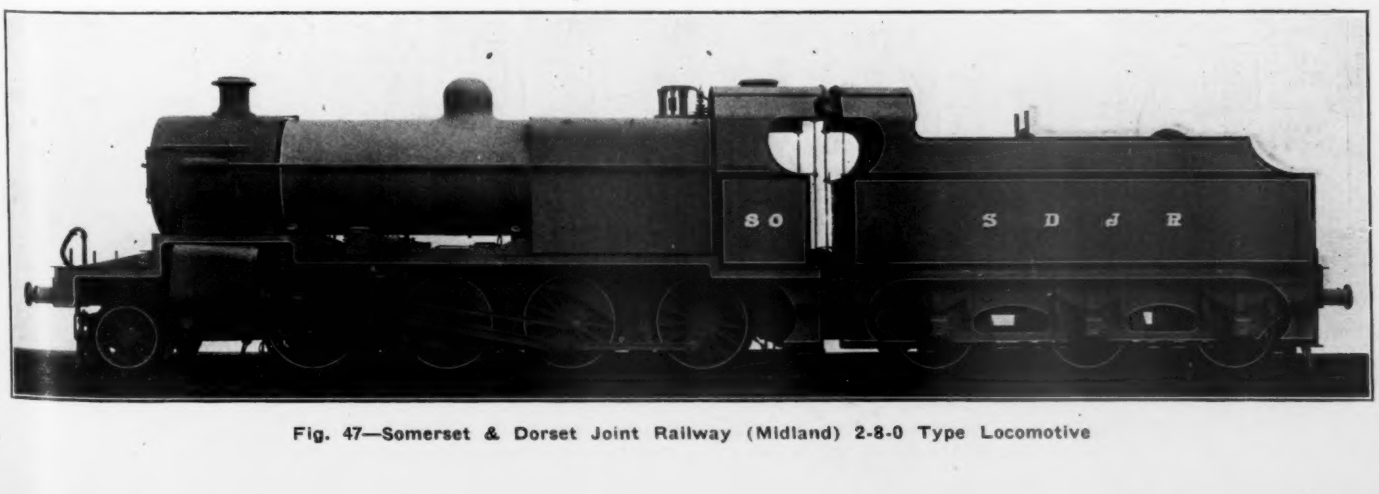
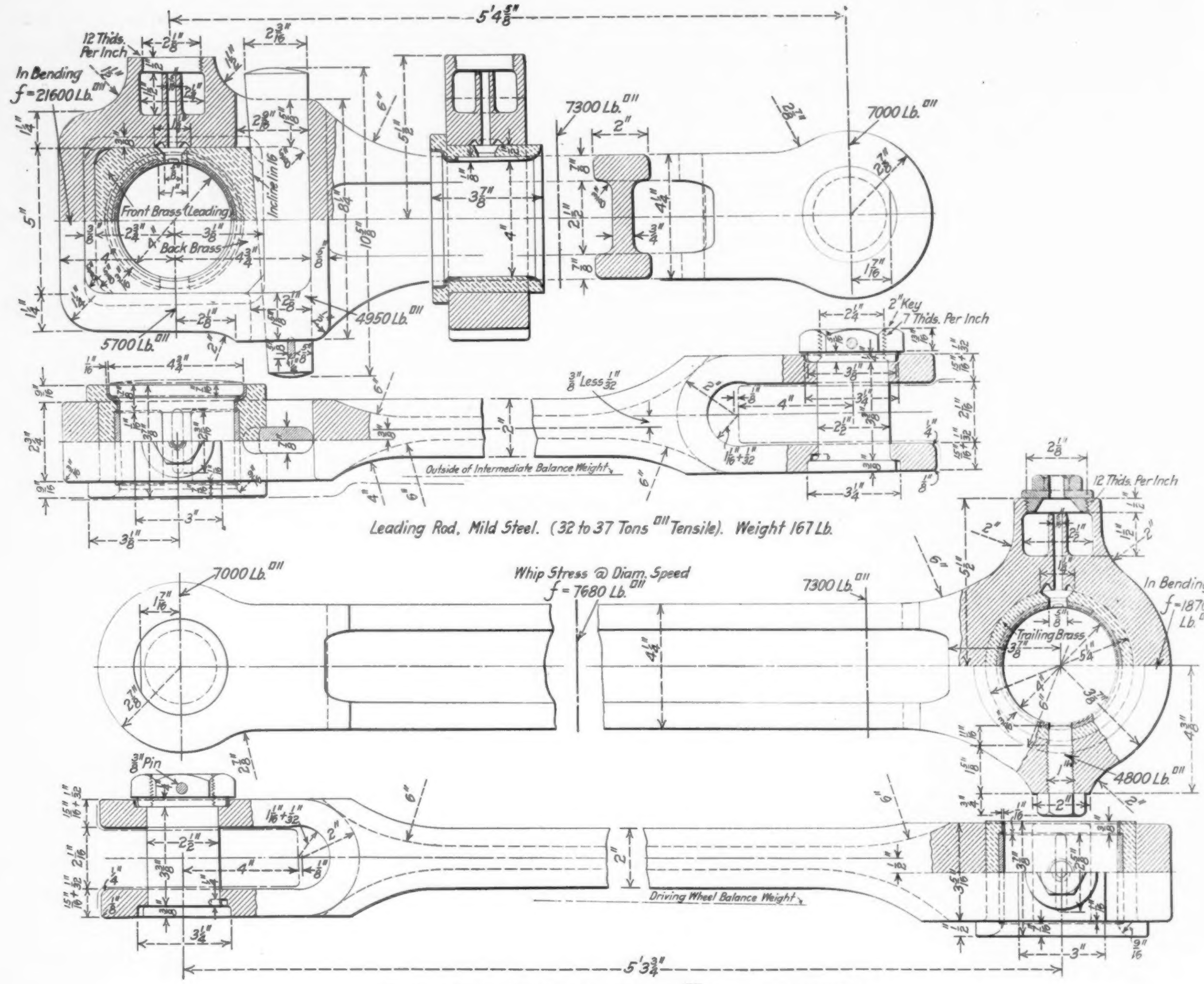


Fig. 47—Somerset & Dorset Joint Railway (Midland) 2-8-0 Type Locomotive



Trailing Rod, Mild Steel. (32 to 37 Tons □" Tensile. Weight 158 Lb.

Fig. 50—Front and Rear Side Rods for 2-8-0 Type Locomotive

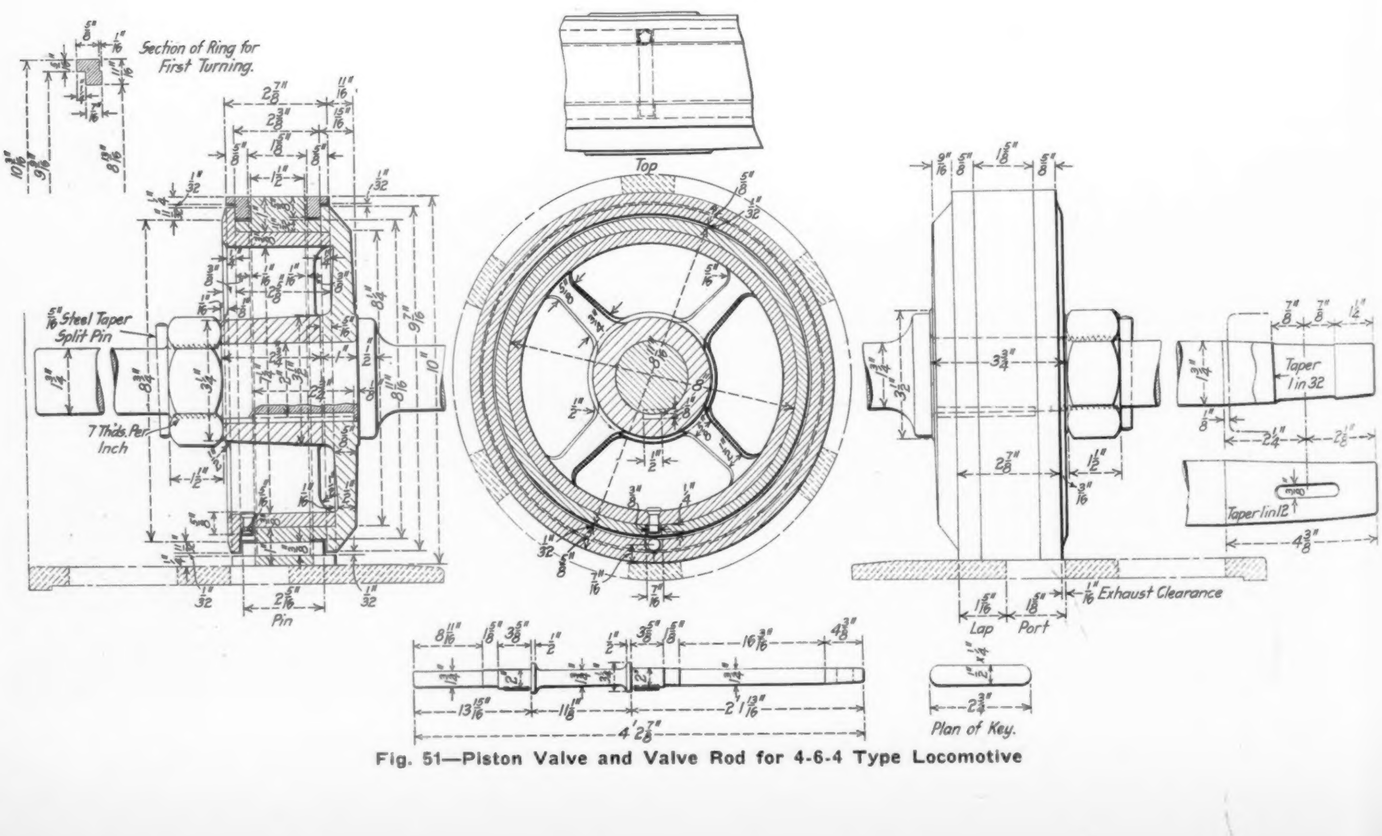


Fig. 51—Piston Valve and Valve Rod for 4-6-4 Type Locomotive

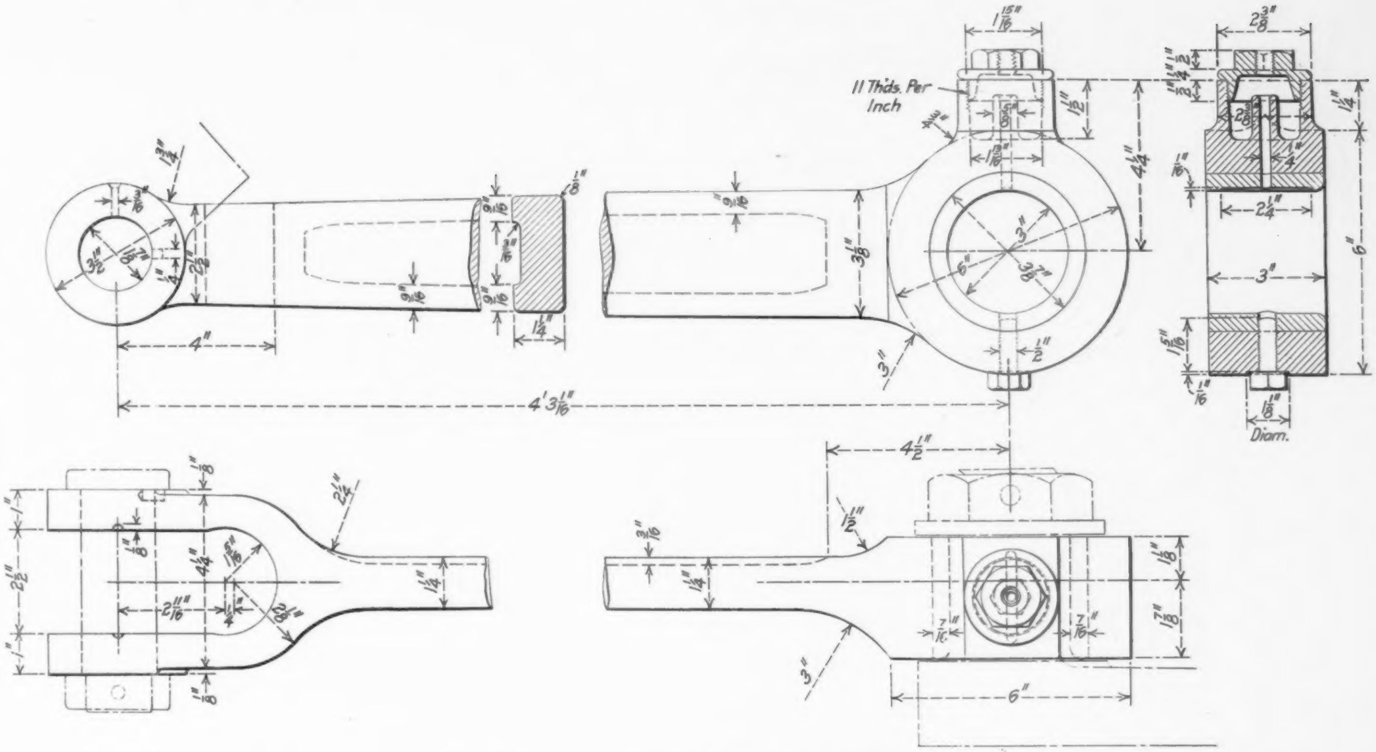


Fig. 52—Eccentric Rod for 4-6-4 Type Locomotive

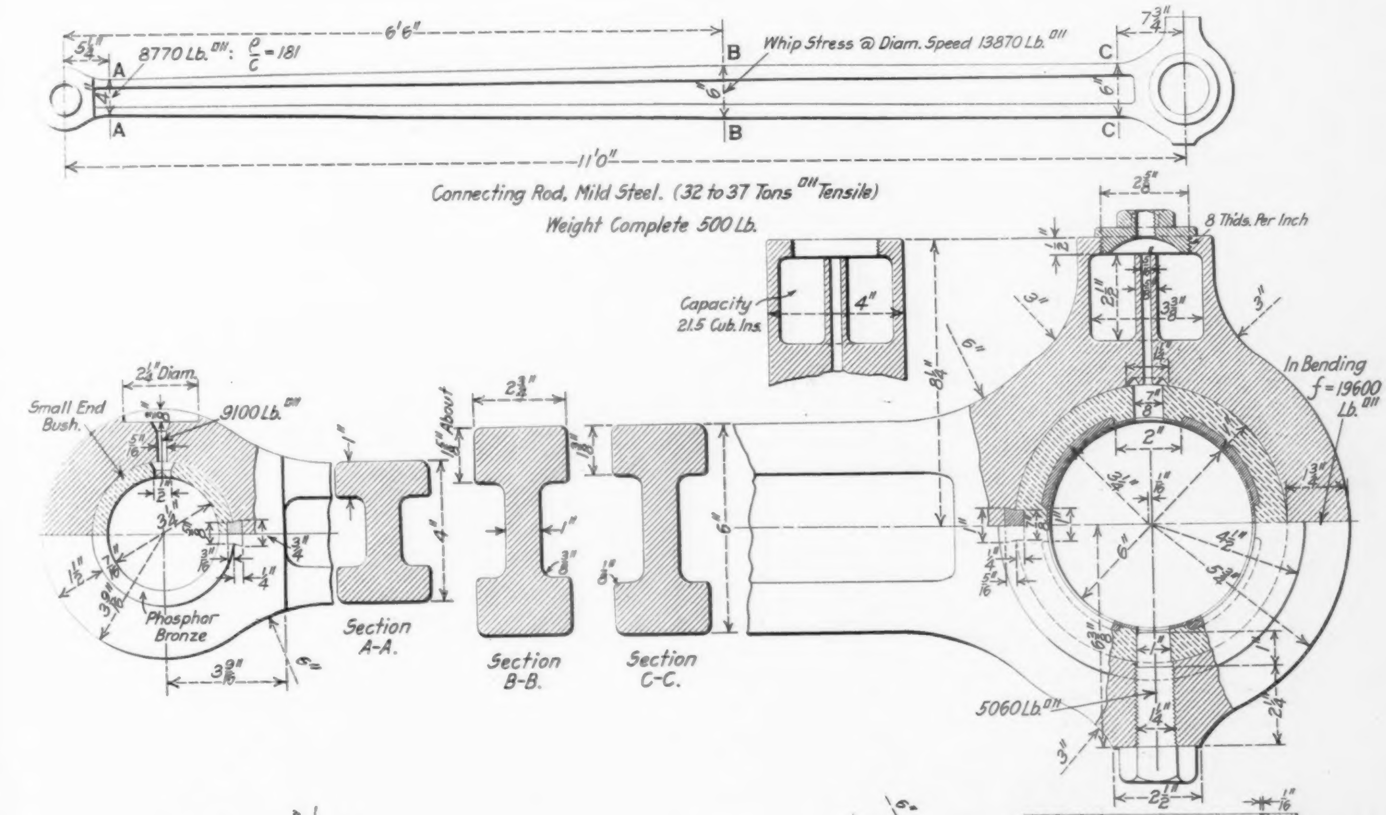


Fig. 53—Main Rod of Somerset & Dorset Joint Railway 2-8-0 Type Locomotive

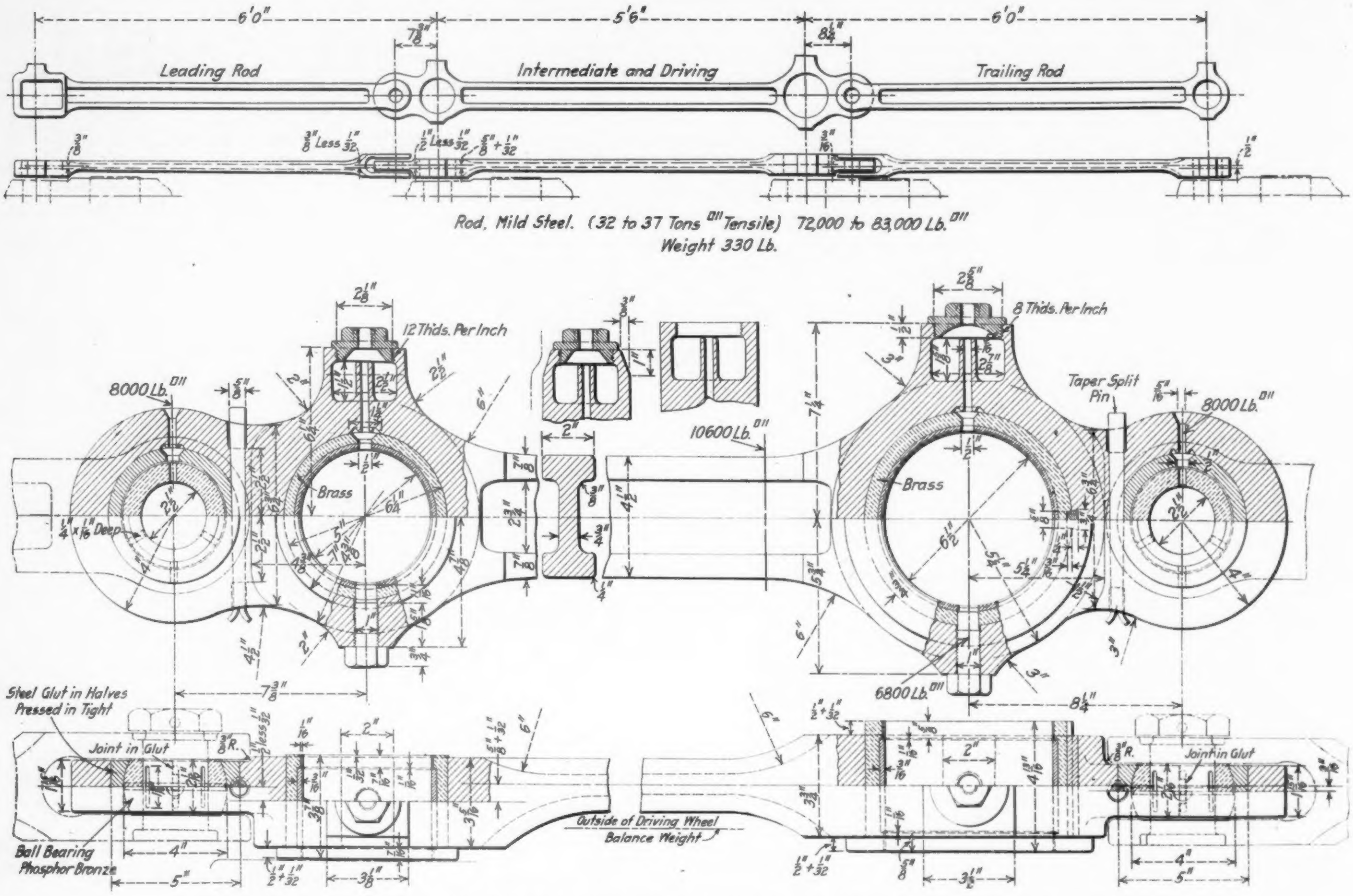


Fig. 54—Intermediate Side Rod for Somerset & Dorset Joint Railway 2-8-0 Type Locomotive

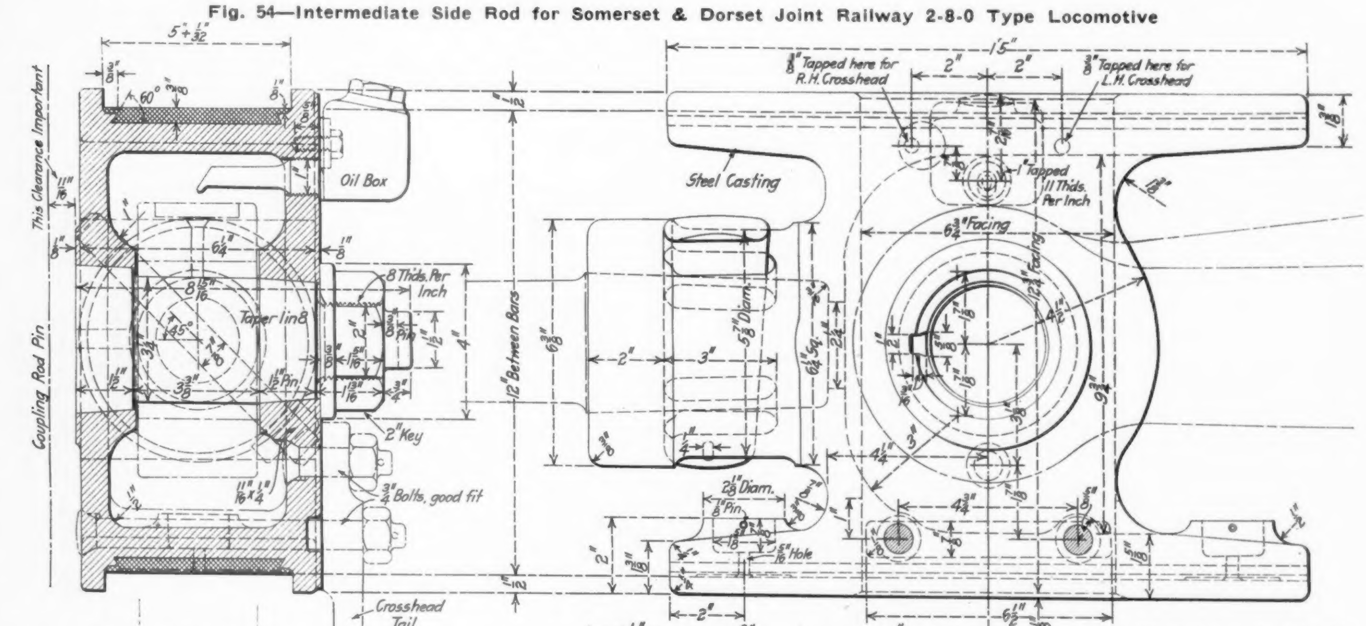


Fig. 55—Crosshead of 2-8-0 Type Locomotive

TABLE XVII—STRESSES IN PISTON ROD AND CROSSHEAD OF SOMERSET & DORSET JOINT RAILWAY (MIDLAND) 2-8-0 TYPE LOCOMOTIVE

Section, and kind of stress	Amount of stress, lb. per sq. in.
Shear on key	13,700
Tension in rod through keyway	11,500
Tension in neck of crosshead through keyway	4,200
Crushing of key on the rod	22,500
Crushing of key on the crosshead	25,500
Bearing pressure, pin on crosshead	6,200
Compression in main shank of rod	8,500

strength of 63,000 to 80,000 lb. per sq. in. with an elongation of not less than 18 per cent in 2 in. This crosshead with its pin and key and combining lever arm weighs only 137½ lb., and by referring to Table XII it will be found that it carries 480 lb. of piston load per pound of weight, which is remarkable.

Briefly, the writer has tried in these articles to cover the details of some of the latest American and English designs

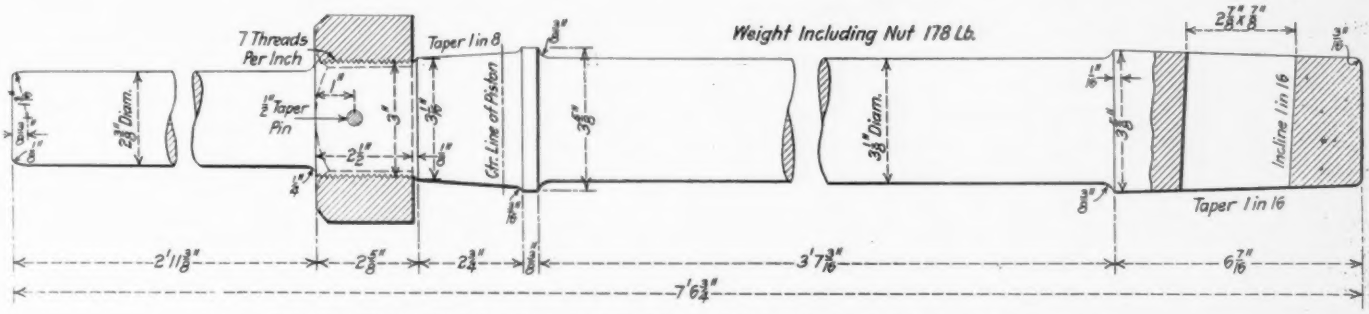


Fig. 56—Piston Rod for Somerset & Dorset Joint Railway 2-8-0 Type Locomotive

of reciprocating and revolving parts. If it shall serve only as a reference and guide for future work it will have served some purpose. In the case of the American locomotives new ground has been broken, and yet the design of these parts can hardly be said to be an experiment. The weight reduction in some of the parts has been startling, but this actual reduction in weight has at the same time reduced some of the stresses, in addition to lightening the pressures on the bearing surfaces. In each case the results have been obtained by a determination not to be hampered by past practice. Every detail has been considered; it has been the saving of a pound here and a pound there that has made a final total saving that has been worth while. This work shows, it is believed, the tendency of locomotive practice in America to-day—the practice of taking each part in detail and studying it in order that the whole may produce a more efficient and a safer machine.

In closing the writer wishes to acknowledge his thanks to J. T. Wallis, general superintendent of motive power, Pennsylvania Railroad; F. A. Torrey, general superintendent of motive power, and C. B. Young, mechanical engineer, Chicago, Burlington & Quincy; F. J. Cole, consulting engineer, American Locomotive Company; J. R. Gould, superintendent of motive power, Chesapeake & Ohio, and to G. J. Churchward of the Great Western, H. Fowler of the Midland, and L. B. Billinton of the London, Brighton & South Coast Railways of England.

DETERMINING THE TEMPERATURE OF OIL QUENCHING BATHS.—The temperature of oil baths for drawing the tempers of tools should be indicated by a thermometer rather than by a pyrometer, because most pyrometers are subject to considerable error at temperatures below 800 deg. F. Thermometers are simpler and not so likely to get out of order.—*Machinery.*

TASMANIAN COAL.—There are abundant seams of marketable coal in Tasmania. They belong to the permo-carboniferous and mesozoic measures, and range from 20 in. to 12 ft. in thickness. In the basin of the Mersey the seams belong to the oldest measures. In the eastern part of the island those of younger age prevail. Eleven collieries are now engaged in producing coal in Tasmania. The output in 1910 was 82,445 tons.—*Engineering.*

LOCOMOTIVE HEADLIGHT REQUIREMENTS

BY E. S. PEARCE

Special Engineer, Cleveland, Cincinnati, Chicago and St. Louis, Indianapolis, Ind.

For the last seven or eight years the legislatures of several states have been active in the enactment of laws relative to locomotive headlights. As a result the subject is more or less inadequately covered by laws of a miscellaneous character and rather indefinite nature, thus causing much embarrassment to the railroads engaged in interstate operation, in their efforts to comply with them. Before going into a discussion of present conditions, a definite idea of the nature of the subject concerning which so much work has been done by both the railroads and the state authorities is essential.

Light may be defined as that which is capable of affecting the sensation of sight, optics being that particular branch of science dealing with the subject. After a considerable amount of research it has been long established that light is a wave motion, and that each particular color of light has a different wave length, varying from .000077 c.m. for red to .000039 c.m. for violet light. Objects are made visible to the human eye by the light rays which are transmitted to the eye, either by reflection of rays from the object to the eye, or by light diffused through an object to the eye. An example of reflection is the visibility of an object located in the path of a beam of light from a headlight; an example of diffusion is the light transmitted to the eye by rays from a signal lamp, the light here being diffused through the lens. That light which is reflected or diffused by or through an object determines the color of the object; or in other words, an object is red because it reflects or diffuses red light rays to the eye, all other rays not being transmitted. Black and white are not considered colors, strictly speaking, for black absorbs all light rays, reflecting or diffusing none, while white reflects or diffuses all light rays, absorbing none.

Light may be classified as to source, as natural and artificial light, natural light being the light originating in the sun, artificial light originating in the flame of an oil or gas light, or the arc of an electric light, or the filament of an incandescent bulb. In order clearly to see an object with the naked eye, the following conditions must be observed:

1.—The object must be sufficiently illuminated; that is, enough light must be transmitted from the object to the eye.

2.—Intense illumination is as much to be avoided as too little. Strong light causes contraction of the eye muscles, and in the event of intense light, the nerves of the eye become paralyzed.

3.—All lights other than those necessary to properly illuminate the field of vision should be eliminated, for by contrast the visibility of the object will be impaired.

4.—The source of illumination should be constant as to intensity, as a flickering light requires too numerous and rapid adjustments of the eye muscles.

5.—The illuminating rays should be of uniform intensity; that is, streaks of bright light are to be avoided.

6.—The object should contrast sufficiently with the surroundings.

Among the terms most commonly used in speaking of the relative intensities of different sources of illumination are candle power, foot-candles, lumens, and apparent beam candle power. These may be defined as follows:

Candle Power.—The quantity of light emitted from any source is measured in candle power, a candle power being the amount of light emitted in one second by a sperm candle burning 120 grains per hour.

LOCOMOTIVE HEADLIGHT REQUIREMENTS IN THE VARIOUS STATES

State.	Kind of Light.	Candle Power.	Power measured with Reflectors.	Distance.	Objects to be Discerned.	Engines Affected.	Remarks.
Arizona	Electric	1,500	No	....	......	Switch Engines Exempt	
Arkansas*	Optional	1,500	....	....	......		
California*	Optional	....	....	800 ft.	Man.	Passenger and Freight	
Colorado*	Optional	1,200	No	....	......	Switch Engines Exempt	
Florida	Optional	2,500	....	....	......	Switch Engines Exempt	
Georgia*	Electric	....	23 in.	....	......	Switch Engines Exempt	300 watts at the arc required.
Illinois	Optional	....	....	800 ft.	Man.	Passenger	
				450 ft.	Man.	Freight	
				250 ft.	Man.	Switch	
Indiana	Optional	1,500	No	....	......	Switch Engines Exempt	
Iowa	Optional	....	....	1,100 ft.	......	Passenger and Freight	
Kansas*	Optional	....	....	800 ft.	Man.	Passenger and Freight	
Michigan	Optional	....	....	350 ft.	Whistle Post	Passenger and Freight	
Minnesota*	Optional	1,500	No	....	......	Passenger and Freight	
	Optional	50	No	....	......	Switch	
Mississippi*	Electric	....	18 in.	....	......	Switch Engines Exempt	300 watts at the arc required.
Missouri*	Electric	1,500	Yes	....	......	Switch Engines Exempt	
Montana	Optional	1,500	No	....	......	....	
Nebraska*	Optional	....	....	600 ft.	Man.	Passenger and Freight	
Nevada	Optional	1,500	....	....	......	Switch Engines Exempt	Engine to and from shops exempt.
New Mexico	Optional	....	....	800 ft.	Man.	Switch Engines Exempt	
North Carolina*	Electric	1,500	No	....	......	Switch Engines Exempt	
North Dakota	Optional	1,200	No	....	......	Switch Engines Exempt	
Ohio	Optional	....	....	350 ft.	Whistle Post	Passenger and Freight	
Oklahoma	Optional	1,500	No	....	......	....	
Oregon*	Optional	....	....	800 ft.	......	Passenger and Freight	
South Carolina	Optional	10,000	Yes	800 ft.	Man.	Passenger and Freight	Engine to and from shops exempt.
South Dakota	Optional	1,500	No	....	......	Switch Engines Exempt	
Texas	Optional	1,500	No	....	......	Switch Engines Exempt	
Vermont	Optional	2,500	Yes	450 ft.	......	Switch Engines Exempt	A. R. M. M. A. recommendation.
Virginia	Optional	500	Yes	....	......	All Locomotives	A. R. M. M. A. recommendation
Washington	Electric	....	....	....	......	All Locomotives	To be approved by Ry. Com.
Wisconsin*	Optional	....	....	800 ft.	Man.	....	

*Special exemptions as to length of interstate or intrastate operation.

Foot Candles.—The unit of density of the illumination emitted from a source of light is termed the foot-candle, as shown in Fig. 1 at *A*. The illumination falling on any point X_1, of the plane *XY*, which is one foot distant from the source *I* of one candle power, is one foot candle.

Lumen.—The intensity of the light given a surface by a source of light is measured in lumens per square foot; that is, a surface one square foot in area, one foot from a source of illumination of one candle power, receives an illumination of one foot-candle upon every point within that area.

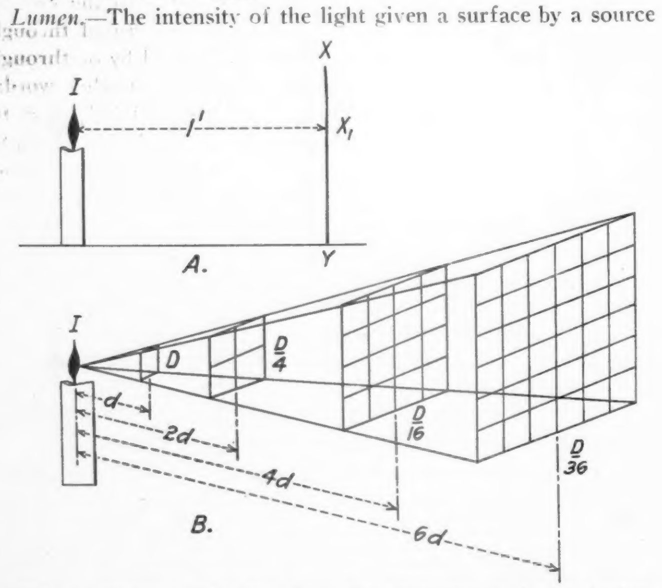


Fig. 1—Diagram Showing How the Intensity of Light Varies

Apparent Beam Candle Power.—That amount of illumination thrown upon a surface from a source of light by virtue of its being so projected by means of a reflector is measured in apparent beam candle power. To produce the same number of foot-candles from an unreflected source of light would, therefore, require a source of greater intrinsic candle power. That the intensity of the illumination varies inversely with the distance from the source may be seen from Fig. 1 at *B*. At a distance *d*, the density of the illumination would be *D* lumens, while at a distance *2d*, the density would be D ÷ 4 lumens.

The quantity of light emitted from a source of illumination is measured by means of the photometer, the quantity being expressed in candle power. Fig. 2 shows a simple form of photometer, the operation of which is based on the principle of inverse squares, as stated above. The apparatus consists of a standard candle *I*, placed a fixed distance from the screen *S*; two mirrors M_1 and M_2; two partitions *A*, with circular openings the same size, placed equidistant from *S*; a scale *C*, used to indicate the distance *Y* of the light *L*, of unknown candle power, from the screen *S*; two openings *O* which enable the operator to simultaneously observe the two mirrors M_1 and M_2, the whole enclosed in a light-proof box and operated in a light-proof room. On the screen *S* is a small grease spot *D*, by means of which the light from *I* is diffused through *S* and reflected in the mirror M_2, while the light from *L* is diffused and reflected in the same manner through *S* on M_1. By observing the two reflections in M_1 and M_2, through *O*, the experimenter regulates the distance of the light *L* of unknown density from *S*, until the image of the grease spot in both mirrors disappears on account of the reflecting and diffusing of the two sources being equalized, which occurs when the candle powers *I* and *L* are to each other as the squares of their respective distances from the screen *S*. With a standard candle *I* one foot from the screen and a light *L* three feet from the screen, with no image of the grease spot in either mirror, the density of illumination of the unknown light would be known to be nine candle power.

The amount of illumination necessary to enable an object to be seen, or the number of foot-candles required, varies widely on account of the following conditions: Eyesight of the observer; coefficient of reflection of the object, or the ability of the surface receiving the light rays to reflect them; contrast between the light reflected by the object with that reflected by the sur-

roundings, and the alertness of the observer, whether forced or natural, due to occupation and habits.

The Master Mechanics' Association committee on Locomotive Headlights in its report shows that a dark object the size of a man could be seen at 450 ft. with an illumination of approximately .038 foot-candles. A similar medium-colored object was seen at 625 ft. by an illumination of .028 foot-candles, and a light-colored object was seen at 975 ft. with an illumination of .008 foot-candles. The method of conducting these tests took into consideration the four conditions cited above. The intensity of the illumination to which the eye can adjust itself varies considerably. A normal eye can work well with light varying in intensity from fractions of a foot-candle, as cited from the committee report, to five foot-candles, the latter, however, usually being higher than the eye can advantageously utilize. The injurious effects of lights having a high beam candle power, was clearly demonstrated in the headlight committee's test at Columbus, classification lights disappearing at 40,000 apparent beam candle power when the observer was confronted by a light of such intensity.

In view of the foregoing facts concerning the nature, propagation and theory of light and the conditions necessary to adequate illumination, the problem the state legislatures have at-

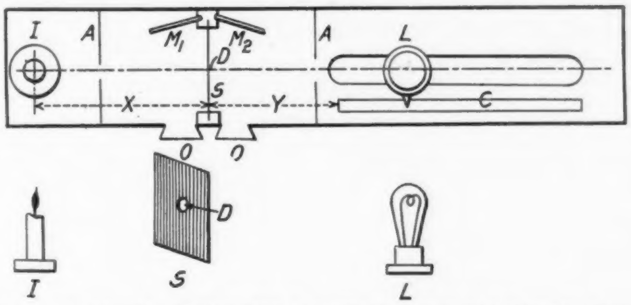


Fig. 2—A Simple Photometer for Determining the Candle Power of Lights

tempted to solve by enacting the present headlight laws will be seen to be of a more complex nature than was evidently appreciated by the instigators of the various bills. From the accompanying table it will be seen that there are 12 states east of the Mississippi river with headlight laws, and 18 states west of the Mississippi. It can readily be seen from this that the haste of the various state legislatures in making laws on a subject requiring considerable investigation, not only by experts on the subject of illumination, but more especially by men actually engaged in the operation of the railroads, has resulted in the enactment of laws which show a disregard for the fundamental principles involved. This fact is evident from the statements of requirements which specify candle powers of high value—too high for safety, as has been demonstrated—the candle powers to be measured with and without reflectors, as the case may be, regardless of the fact that the reflector is as much a part of the light as the flame itself, so far as adequate illumination is concerned. The candle power of the light is not the important factor, but the foot-candles thrown upon the object to be seen.

It is worthy of note that two states, Vermont and Virginia, have taken advantage of the results of the exhaustive tests conducted by the Master Mechanics' Association Committee on Headlights. Vermont has enacted a law, effective April 1, 1915, which in substance states that a light of 2,500 apparent beam candle power measured with the aid of reflector, such readings of candle power being taken on a reference plane 3 ft. above the rail at distances between 500 and 1,000 ft. in the center of the track, the minimum beam candle power to be required at each station being specified, will meet the requirements of an efficient headlight, thus conforming to the recommendations of the Master Mechanics' committee.

Such a law eliminates the necessity of using a high power electric headlight, the use of which has been demonstrated to be a dangerous practice, and admits all makers of such appliances to the field of development, whether their product be oil, gas, or electric. From the present status of the subject as regards state laws, it is evident that until such time as a federal law is enacted which will adequately aid fairly cover the various conditions to be encountered in train operation, the railroads are going to be subjected to constant annoyance and considerable expense in their efforts to comply with laws, indefinite, inadequate and impracticable in nature, the enforcement of which cannot be justly carried out by the state authorities.

DIAGRAM FOR DETERMINING PERCENTAGE OF MAXIMUM TRACTIVE EFFORT

BY L. R. POMEROY

The illustrations show a method of determining by the means of combination curves the percentage of the maximum tractive effort which is available with various speeds, diameters of driving wheels and stroke. Consider for example a Consolidation type locomotive with cylinders 25 in. by 30 in., 52 in. diameter driving wheels, 217,500 lb. weight on drivers, 27,000 lb. on the engine truck. The tender weighs loaded 170,000 lb., giving a total weight of engine and tender of 421,500 lb. The locomotive has 202 sq. ft. of firebox heating surface, 26.5 sq. ft. of arch tube heating surface, a tube heating surface of 2,919 sq. ft. and a superheater surface of 594 sq. ft. Taking one and one-half times

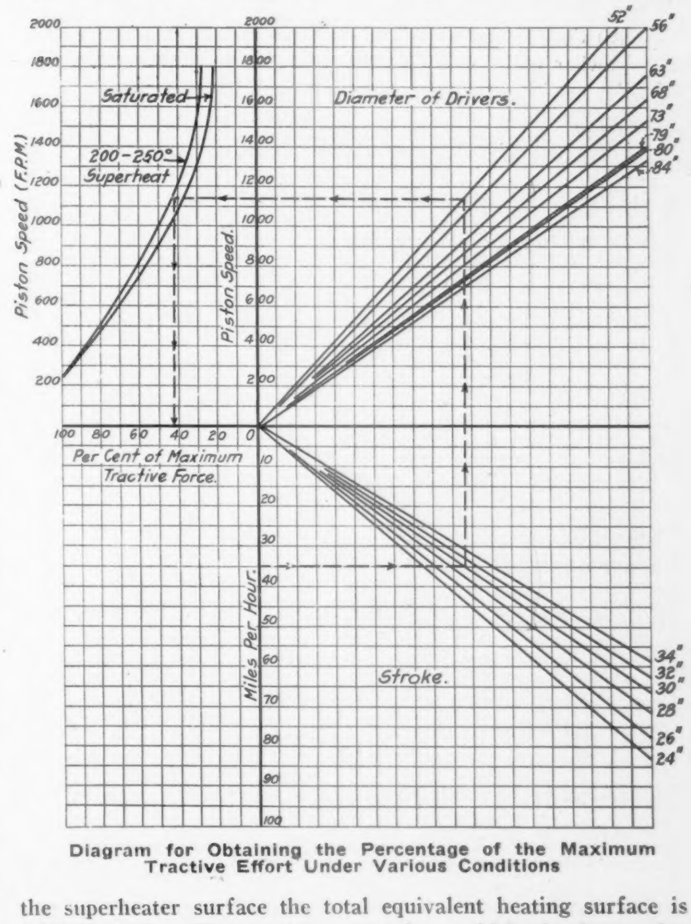


Diagram for Obtaining the Percentage of the Maximum Tractive Effort Under Various Conditions

the superheater surface the total equivalent heating surface is 4,038.5 sq. ft. The maximum speed at which the locomotive can exert its maximum tractive effort is $\frac{125 \times 4038.5}{61298 \text{ lb.}} =$ or 8.2 miles per hr., the maximum tractive effort being 61,298 lb.

In order to determine the gain or loss if the speed of operating the locomotive is increased from 35 miles per hr. to 45 miles per hr., we may read from the diagram the piston speed and the percentage of the maximum tractive effort obtainable at 35 miles per hr., the latter being 43 per cent. and the piston speed 1140 ft. per min.; at 45 miles per hr. the piston speed is 1480 ft.

per min., and the available tractive effort is 32 per cent. of the maximum. The increase in speed is $\frac{45}{35} - 1 = \frac{45}{-} - 1 = 28$ per cent. and the equivalent decrease in tractive effort is $1 - \frac{32}{43} =$ 25½ per cent.

Assuming that the gross ton-miles, which takes account of the entire weight of the engine, tender and train, is proportional to the miles per hr., multiplied by the percentage of available tractive effort at different speeds, the percentage of the gross ton-miles is

35 m. p. h. x 0.43=15.05
45 m. p. h. x 0.32=14.40

The percentage of gross ton-miles at 35 miles per hr., as compared with that at 45 miles per hr. then equals $\frac{15.05}{14.40} - 1 = 5$ per cent. greater at 35 miles per hr. than at 45 miles per hr. This consideration is entirely aside from a disadvantage from a mechanical and maintenance standpoint of increasing the piston speed from 1140 ft. per min. to 1480 ft. per min., while the decrease in horsepower also amounts to 4 per cent. With this particular locomotive the average horsepower at 35 miles per hr. and 45 miles per hr. is about 2200. (The maximum h. p. is reached at a piston speed of 1000 ft. per minute, beyond which the h. p. diminishes). At the rate of 2.7 lb. of coal per h. p. hr. the coal per hr. necessary to develop this h. p. would be 5,940 lb., which is about the limit of the average fireman under the most favorable conditions.

When the calculation is based on the available trailing load or the drawbar pull, the disadvantage of increasing the speed from 35 miles per hr. to 45 miles per hr. is considerably greater.

At 35 miles per hr. under the conditions named:

Maximum available tractive effort, 61,298, at 43 per cent.		= 26,358 lb.
Engine friction, weight on drivers x 1.11 per cent.	= 2,414 lb.	
Weight on engine truck + 2/3 weight of tender=145,000 lb. at 2 lb. per 1,000 lb.	= 290 lb.	
Head end resistance .002 x $(mph)^2$ x 120 sq. ft area	= 294 lb.	
	2,998 lb.	
16 deg. curve (equivalent to 0.64 per cent. grade, or 12.8 lb. per ton) weight of engine and tender in tons x 12.8	= 2,317 lb.	
3 per cent. grade, 181 tons at 6 lb.	= 1,086 lb.	
Total locomotive resistance	= 6,401 lb.	6,401 lb.
Net available tractive effort		= 19,957 lb.
Available tons back of drawbar for 70-ton cars (tare and lading) 3 lb. per ton + 16 deg. curve + .3 per cent grade (3 + 12.8 + 6) = 21.8 lb. resistance of trailing load = $\frac{19957}{21.8}$		= 917 tons

At 45 miles per hr.:

Maximum tractive effort, 61,298 at 32 per cent.		= 19,615 lb.
Engine friction, as above (2414 + 290)	= 2,704 lb.	
Head end resistance (.002 x $(mph)^2$ x 120 sq. ft.)	= 486 lb.	
Resistance of 16 deg. curve .3 per cent. grade (2317 + 1086)	= 3,403 lb.	
Total engine resistance	= 6,593 lb.	6,593 lb.
Net available tractive effort		= 13,022 lb.
Available tons back of drawbar for 70-ton cars (curve, grade and friction) (3.25 + 12.8 + 6) as above $\frac{13022}{22.05}$		= 591 tons

Ton-miles per hour

(a) 35 mph x 917 tons = 32,095 ton-miles
(b) 45 mph x 591 tons = 26,595 ton-miles

In favor of 35 miles per hr.: $\frac{32095}{26595} - 1 = 20$ per cent.

ROAD TESTS FOR DETERMINING FRONT END CONDITIONS

BY E. S. BARNUM

The problem of proper drafting has been a live subject since the locomotive was in its infancy. It is doubtful if we could find a roundhouse foreman who did not think he could give the last word on the proper way to make a locomotive steam. However, when his practice was analyzed, it would be found that in 99 cases out of 100, the exhaust nozzle had been so much reduced that the locomotive could not help steaming. Reductions in the size of the exhaust nozzle are usually made without regard to the high back pressure caused in the cylinders, which

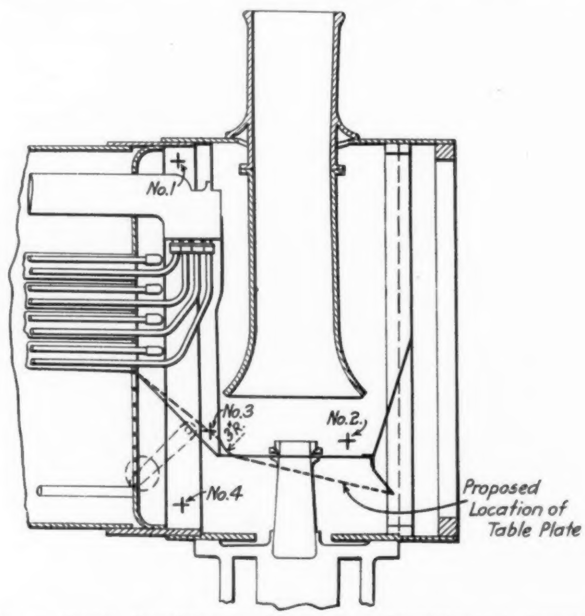


Fig. 1—Draft Readings to Determine Condition of Passages

means a logy engine and an increase in the coal consumption.

On a very few of the largest railroads, having a testing plant or access to such facilities, front end arrangements can be tried out and standards established for the various classes which will give satisfactory and economical results. But how are roads without access to such facilities to obtain indication of any accuracy as to the efficiency of front ends? A possible answer is that it is unnecessary, as the locomotive builders take care of the design and furnish front ends which fulfill the conditions; but it would not take a very deep or extensive investigation to disprove this.

The most satisfactory method is to make road tests under service conditions. If the underlying principles are well understood, reliable data can be secured with the help of not more than two observers using very simple and inexpensive apparatus. Operating conditions do not have to be disturbed in the least.

The front end does work in producing draft and it does this work at the expense of back pressure in the cylinders. The measure of the efficiency of a front end is the number of units of draft it will produce per unit of cylinder back pressure. However, with the same style of nozzle, the back pressure varies

inversely with the area of the nozzle, and as we must have a locomotive that will steam, it is not essential that we measure the back pressure with indicators. What is necessary is to measure the amount of draft in a number of places in the front end and localize the points at which there are serious losses in the velocity of the gases.

Doctor Goss and other experimenters have proved that to

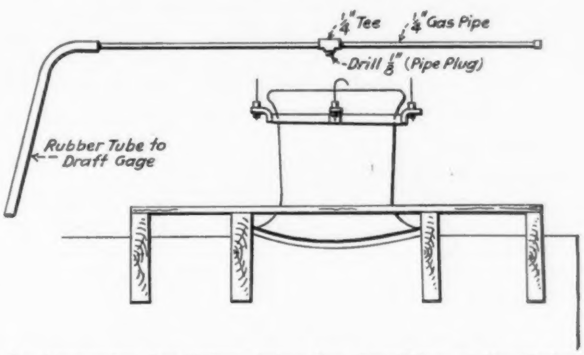


Fig. 2—Apparatus for Determining the Condition of the Exhaust in the Stack

secure the best results, the following conditions must obtain:

1.—The exhaust element (exhaust column, nozzle, lift, pipe and stack) must be in line.

2.—The gas passages in the front end should be smooth and free from angles which tend to cause eddies and unnecessary friction.

3.—The exhaust should fill the stack at a point about three or four inches from the top.

4.—There should be no obstructions in the path of the exhaust, as they influence it, and objects near the exhaust have the same influence in a lesser degree.

The exhaust elements should be lined up in the shop previous

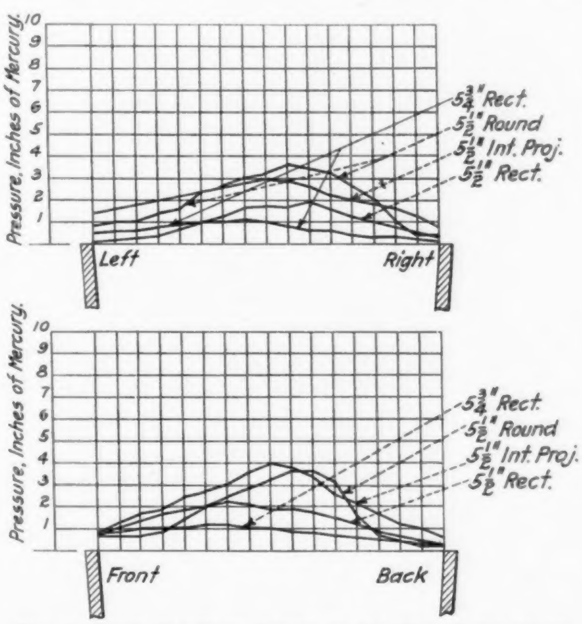


Fig. 3—Draft Readings Taken at the Top of the Stack

to the road tests. This leaves three conditions to obtain by trying out under actual operating conditions. By selecting runs, fairly uniform tonnage may be secured. As the tests should be over the same piece of road each trip, the conditions are similar.

In order to determine whether or not the gas passages of the front end are smooth and do not offer too much friction, draft readings should be taken simultaneously at a number of locations. Fig. 1 shows such locations on a locomotive with a superheater. The readings are secured with an ordinary U draft gage placed in the cab, suitable piping being provided for the purpose. Some actual results obtained in tests are shown below.

Location	No. 1	No. 2	No. 3	No. 4
Draft—inches of water	5.1	9.1	5.1	5.8

Readings at location No. 2 show quite a variation from the other three. The trouble has been localized and we should rearrange the table plate and remove the adjustable diaphragm as indicated by the dotted line in Fig. 1.

Next we come to the location of the exhaust in the stack.

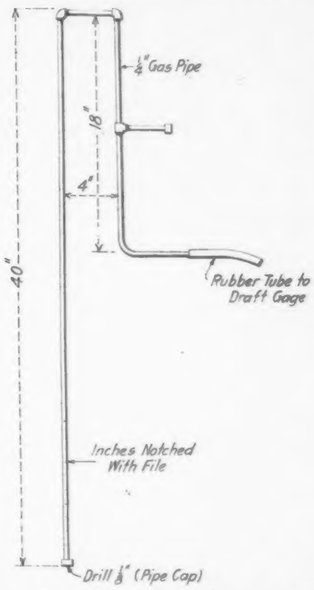


Fig. 4—Device for Locating the Point at Which the Exhaust Strikes the Stack

Referring to Fig. 2, it will be noted that a wooden platform has been built around the stack large enough to accommodate an observer. There is a band around the stack having four hooks which project above the stack and in which a 1/4-in. pipe can be slipped. This section of pipe is shown just above the stack and

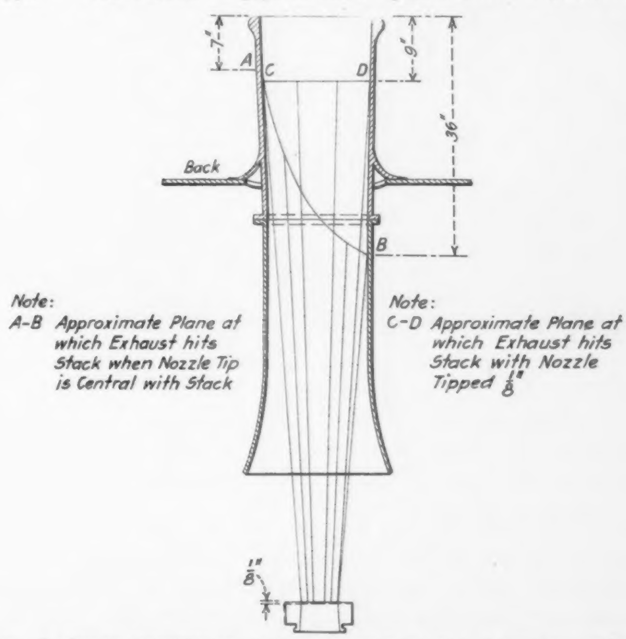


Fig. 5—Stack Conditions as Determined by the Apparatus Shown in Fig. 4

it will be noted that there is a tee in the center in the lower opening of which there is a pipe plug which has a 1/8-in. hole drilled in it. By moving the pipe across the stack an inch at a time with the tee pointed downward a series of readings will be obtained on the draft gage, which, when plotted, will give curves as shown in Fig. 3.

An arrangement for locating the point at which the exhaust

strikes the stack is shown in Fig. 4. The end with the pipe cap on it is moved up and down against the inside of the stack until the point of no pressure, or vacuum, is located. This is the point at which the stream of exhaust steam just begins to come in contact with the stack and it can be located within an inch. Several of these points located around the stack will give a plane as indicated in Fig. 5. It will be noted that the exhaust was hitting the stack 9 in. from the top at the back and 36 in. from the top at the front. This was a condition found in actual road tests and the cause can only be found by a process of elimination. On lowering the nozzle ⅛ in. at the back the exhaust hit the stack squarely all around.

Different depths of fire in the firebox will cause a variation in the amount of draft in the front end. This is a fact the observer should not lose sight of. If, however, his draft readings have been taken from the different locations at the same time, the relation between each set of readings will necessarily be the same.

MODEL LOCOMOTIVE BUILT BY APPRENTICES

A complete working model of a Pacific type locomotive has recently been completed by the apprentices at the Dunmore, Pa., shops of the Erie Railroad. This work was undertaken under instructions from the management as a test of the proficiency of the boys in reading drawings and working to scale, and the engine was built from the drawings of a class K-4 Pacific type to a scale of ¾ in. per foot. It is 57 in. long over all and rests on a short section of stone ballasted track of 3⅝ in. gage.

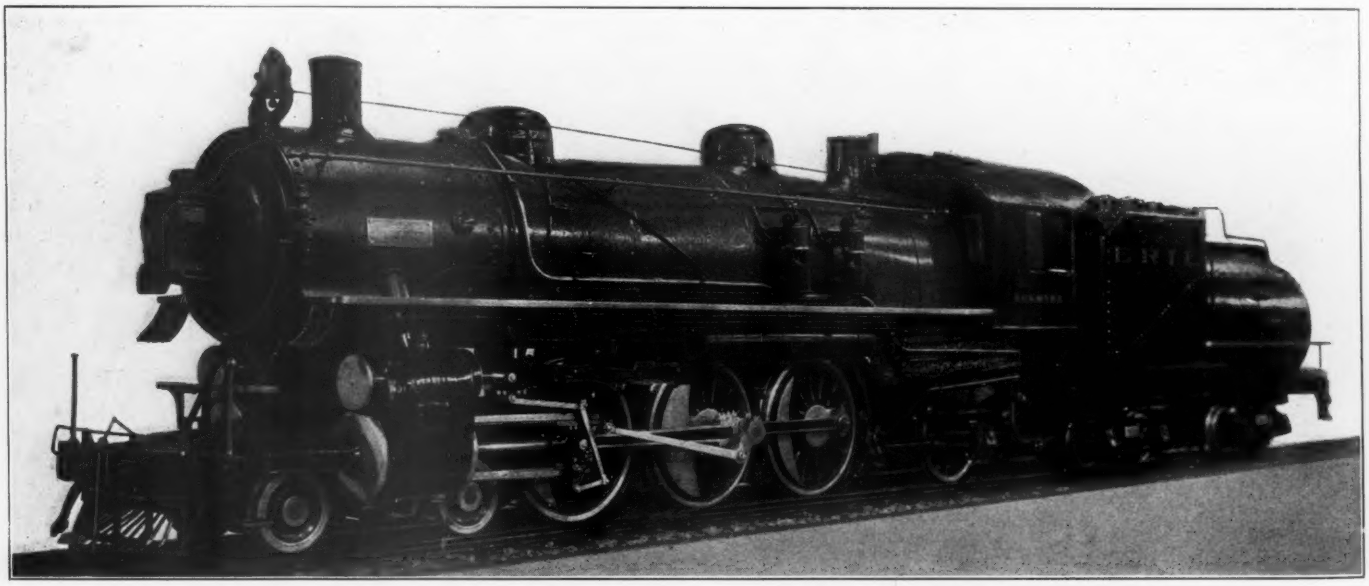
The instructions authorizing the building of the model specified that it was not to interfere in any way with the regular shop work, and it was therefore built entirely in the schoolroom, the work being done by the apprentices under their own shop organization. One of the boys was appointed general foreman by the instructor, a set of blue prints turned over to him and the completing of the organization and the prosecution of the work was left in his hands. Two other foremen were selected by him and the three then decided to select fifteen apprentices from the various departments to be worked in gangs of five boys each under the supervision of the three foremen.

The next step was the equipping of a small machine shop to handle the work. This was assigned to one of the gangs which designed and constructed a small lathe, drill press and shaper, the task of building a small motor being assigned to the electrical apprentice. The building of these tools was necessary because the small size of the model made the use of the machine tool equipment in the main shop impracticable. While the machine tools were being built a set of small taps and dies were made by the tool room apprentice.

To the second gang was assigned the preparation of a set of drawings of the locomotive details to the required scale, and as fast as these were completed the pattern shop apprentices were started on the construction of the necessary patterns. These were turned over to the foundry apprentices and castings made. At the end of ninety days the two gangs, with the assistance of the electrical, patternmaker and foundry apprentices had converted the apprentice schoolroom into a locomotive shop which was stocked with enough material to provide for the beginning of actual work on the model, the third gang being added to the force at this time.

Considerable ingenuity was exercised in meeting the demand for special classes of material from the resources at hand. Sewing needles were used to provide hardened pins 1/64 in. in diameter for use in the Baker valve gear, and air hose was obtained by stripping the insulation from No. 28 copper wire.

Work was started during the month of September, 1915, and in 200 working days the model was completed ready for shipment to the office of the general mechanical superintendent in New York City. It was built under the supervision of H. E. Blackburn, apprentice instructor at Dunmore, and is now being exhibited in the window of the Erie's uptown ticket office at Broadway and Thirty-third street, New York.



Model Locomotive, 57 Inches Long, Built by Erie Apprentices at Dunmore, Pa.

Aluminum.—The consumption of aluminum is constantly expanding. It is the most abundant of metals and ranks third among the elements which compose the crust of the earth, being exceeded only by oyxgen and silicon. According to the United States Geological Survey the quantity of aluminum consumed in the United States in 1914 was 79,129,000 lb., against 72,379,000 lb. in 1913, and 65,607,000 lb. in 1912. The growth of the industry is shown by the fact that the production was 150 lb. in 1884, 550,000 lb. in 1894, and 8,600,000 lb. in 1904. The value of the exports of aluminum and of manufactures of aluminum amounted to $1,546,510 in 1914, as compared with $966,094 in 1913.—*American Machinist.*

CAR DEPARTMENT

INSPECTION AND REPAIRS OF FREIGHT CARS BY PIECEWORK*

BY J. J. TOLIN
Foreman Car Repairs, Pennsylvania Railroad

The inspection and repairs of freight cars on a shop repair track should be divided into three classes:

(1) Light repairs which should take in the renewal of wheels, couplers, draft timbers, arch bars, and all repairs of a minor nature.

(2) Heavy repairs to wood or composite cars, which should include renewal or splicing of sills, renewal of roofs, or the complete rebuilding of car body when found necessary.

(3) Heavy repairs of steel cars, which should include the renewal or splicing of sills, renewal or patching of sheets, or the cutting down and rebuilding of the entire car, when necessary.

Each of these classes should then be sub-divided into two classes, namely: The air brake apparatus and its connections, and the other parts of the car. There should be two sets of piecework inspectors and repairmen, one to be a specialist on the air brake apparatus, and the other on the other parts of the car.

The piecework inspector, supervising repairs to parts other than air brake, should, on the arrival at the repair track of a car requiring light repairs, make a thorough examination of the wheels, journal boxes and contained parts, arch bars, brake-beams, and all parts below the body of the car. At the same time he should note the condition of draft timbers, couplers, end sills, and all parts that are visible from the ground. He should then make the roof inspection, paying particular attention to brake wheel, ratchet wheel, and pawl, to see that the hand brake can be operated, and that the brake pawl will properly engage the teeth of the ratchet wheel. The deck handles and running board also demand preferred attention since they are essential parts. Next the interior of the car should be inspected, assuming that it is an empty house car, and repairs should be made according to the class of freight which the car is to carry.

The authorized piecework card should then be prepared, listing all defects which, in the judgment of the piecework inspector, should be repaired; he should bear in mind that only such repairs as are necessary to make the car safe for trainmen and for lading suitable to it should be made to foreign cars. While making repairs the repairman should be guided by the piecework card and should not be permitted to repair any defect that had been overlooked by the piecework inspector without first calling it to the attention of the piecework inspector and having it added to the piecework card if the inspector decides that the defect should be repaired.

The air brake piecework inspector should make a thorough inspection of the hose, hose couplings, pipe hangers, pipe supports, cylinder and reservoir and their blocks, to see that they are in good condition and firmly secured to the car. He should then fill out the authorized piecework form noting any defect that he may have discovered.

The car is now ready for the air brake repairman. He should first read the piecework card and then proceed to make the repairs. When this has been done he should attach the yard air line to the air hose at one end of the car and a dummy coupling to the hose at the other end and open the valve from the yard air line. While the system is charging he should disconnect the retaining pipe from the triple valve and place a nipple with an air gage attached to it in the exhaust port of the triple. Then take a pail of thin soap suds and with the aid of a suitable brush completely cover the air hose and all joints on the brake and cross-over pipe. If a leak in either of these pipes is discovered the piecework inspector should be called to decide whether or not it is of enough importance to repair. When the system is charged and the brakes are applied by making a 25 lb. reduction in brake pipe pressure the length of piston travel should be noted and the brake released by turning the air into the brake pipe through the 1/16-in. opening in the disk located in the ¼ in. pipe on the testing device. The gage, which is attached to exhaust port of the triple, should be carefully watched for one minute and if it shows a leakage in excess of five pounds the defect causing the leak should be located and repaired. After the defect has been repaired a like test should be made to know that the leak has been reduced below five pounds per minute.

The retaining pipe should then be connected to the triple valve and slack adjusted if necessary, paying special attention to the equalization of the brakes; with the retaining valve handle at right angles on a two position or at a 45 deg. angle on a three position, the brakes should again be applied and released. All joints on the retaining pipe should then be covered with soap suds and all leaks repaired, no matter how trifling they may be; the retaining pipe must be absolutely tight, otherwise it is useless. When the air ceases to escape from the exhaust port in the retaining valve turn down the handle. If a gush of air escapes at this time the retainer is in good condition. If air escapes at a very low pressure or no air escapes the retainer is defective and should be repaired or replaced with a new or repaired valve. Under ordinary circumstances the brakes can now be depended on as being in good condition.

It is, of course, understood that both gangs can be working on the car at the same time and thus not waste any time.

Heavy Repairs to Wood or Composite Cars.—A car of this type requiring heavy repairs should be jacked up, placed on trestles and the trucks removed from underneath the car body before inspection is made. The inspector should first thoroughly inspect the longitudinal sills, end sills, cross-bearers, draft timbers, etc. Taking a box car, for instance, he should determine whether or not the general condition of the car will warrant putting it in condition to carry first-class freight. If he decides that it should be made fit for this purpose he should inspect the siding, lining, flooring and grain strips, condemning any of these parts that are not in perfect condition. The roof should then be thoroughly examined for evidence of leaks and if any are found the necessary repairs should be made. All parts of the trucks should be examined and the piecework form prepared, which should show all repairs necessary, except to the air brake apparatus.

While the car is undergoing repairs the work should be closely checked by the piecework inspector to see that both lumber and bolts of proper dimensions are used, that lumber is properly framed, and that holes bored by the repairmen are not more than 1/16 in. larger than the diameter of the bolts or rods that are to be placed in them. He should also see that all parts are applied as shown on standard drawings; that is, the sizes of tenons, mortices, etc., should not be changed by the repairmen to make the part simpler to apply.

The air brake attention in this case is much the same as in that of the car requiring light repairs with the exception of removing and replacing the apparatus, including the pipe where it interferes with the renewal of longitudinal sills. It is also important in this case that the pipe be thoroughly blown out before it is con-

*Abstract of a paper read at the June 16, 1915, meeting of the Niagara Frontier Car Men's Association, Buffalo, N. Y.

check case and the exhaust port with wooden plugs to prevent dust from entering the triple.

Heavy Repairs to Steel Cars.—The all-steel car does not require heavy repairs as frequently as the car of wood construction, but when it does require this class of repairs they are usually more extensive; consequently the number of days out of service per year is approximately the same as that of the wooden car. The number of days out of service can be reduced, however, by increasing the number of men working on the car, and in order to do this and still maintain a high degree of efficiency the men must specialize on some particular kind of work. For instance, cutting off rivets, heating rivets, driving rivets, etc.

My slight experience in the steel car field has taught me that as many as fifteen repairmen can be successfully worked on one car, classified as follows: Cutting off and backing out rivets, four men; repairing bent parts of car, bolting them in place for the riveters and straightening parts on car, four men; reaming and drilling holes, two men; heating rivets, one man; driving rivets, two men; removing and replacing parts that are secured with bolts and repairing trucks, two men. It is, of course, understood that for the practical working out of this arrangement several cars must be on the repair track at one time.

Like the wooden car the steel car should be jacked up, placed on suitable trestles and the trucks removed. All parts that have been affected by corrosion should have the scale removed. The car should then be carefully gone over by the piecework inspector to decide what repairs are to be made and at the same time see to it that no part or parts are removed from the car for repairs that can be successfully repaired in place by using a portable oil heater. He must also exercise good judgment in condemning sheets to be scraped; where it is practicable floor sheets should be patched until an entire new floor is to be applied. When a floor is to be renewed and one or more sheets are found in fairly good condition, they should also be removed and replaced with new sheets and the sheets that are in fairly good condition placed in stock for repairs to floors that are not yet to a point where the entire floor requires renewal.

The splicing of steel longitudinal sills while in place is economical. For illustration, a steel car that has been in an accident and has the longitudinal sills so badly buckled at one or both ends that they cannot be straightened while in place should not be removed for repairs, but the damaged ends should be sawed off, repaired and spliced onto the sills. This can be done at a cost much below that of removing the full-length sills for repairs and the result obtained is just as good, if not better.

The manner in which rivets are driven in steel cars is another important feature. The piecework inspector should inspect each morning all rivets driven by the repairmen the previous day and each rivet should be tapped with a light hammer and any found loose ordered removed. Rivets with poorly formed heads on account of poor heating, or rivets too long or too short, should also be ordered removed and only the rivets that pass inspection should be paid for.

The number of rivets driven should be checked daily by the piecework inspector for the reason that some of them may become covered with other parts and could not be checked at a later date. The rivets that have been checked can easily be identified if bright red paint is used to mark them as they are counted.

The air brake attention necessary is practically the same as in the case of light repairs except that care should be exercised to keep the cylinder, triple valve, cut-out cock, angle cocks, and air hose from coming in contact with excessive heat when straightening parts in place.

A piecework inspector on light repairs should be able to take care of about 20 men; on heavy repairs to wooden cars 30 men, and on steel cars anywhere from 36 to 40.

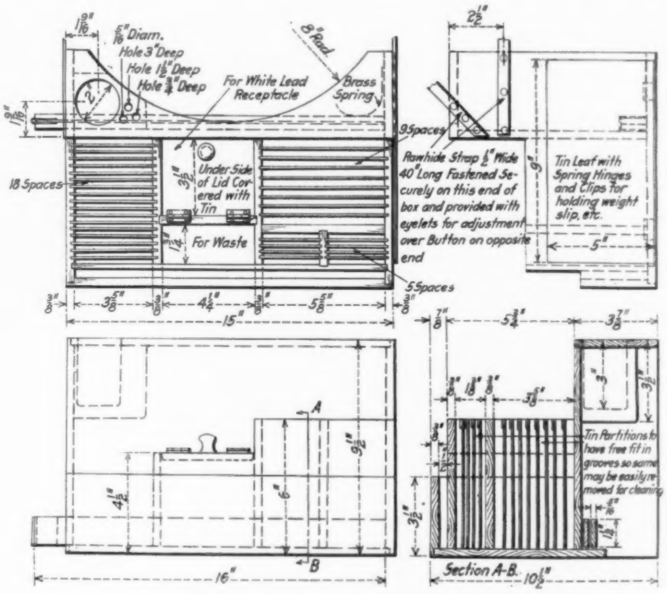
Ships Admitted to American Registry.—The total number of foreign-built vessels admitted to American registry to July 31, 1915, was 150 of 528,408 gross tons.—*Iron Age.*

FREIGHT CAR STENCILING OUTFIT

BY H. F. BLOSSOM
Draftsman, Boston & Maine, Concord, N. H.

The stenciling outfit shown herewith has been in use in the Concord, N. H., shops of the Boston & Maine for some time, and has proved very convenient. It is designed primarily for use in re-stenciling weights on freight cars, both in the shop yard and in the classification yard after cars have been re-weighed. Its chief advantages are the convenience with which the stencils and other equipment may be carried about, ready for instant use, and the accessibility of the equipment during the actual process of stencilling the cars.

8he outfit consists of a well-built whitewood box, 15½ in. long by 10½ in. wide with a back 9½ in. high, which is concaved to fit against the body. Straps are attached, one to pass around the body and another around the back of the neck, which may be adjusted to suit the operator, leaving the hands free at all times. In each end of the case are compartments fitted with vertical tin partitions for holding the various size stencils in



Outfit for Use in Stencilling Cars

numerical order. These partitions should have a loose fit in the grooves so that they may occasionally be removed and cleaned. In front is a space 14¼ in. long for holding longer stencils, such as the words "Weight," "New," etc. One space in the center is used for holding the white lead can and is provided with a hinged lid to keep out dirt. The under side of this lid is covered with tin to provide a palette for the stencil brush. In front of this compartment is a space for holding waste for wiping.

In the back or shield, which bears against the body, is a socket for carrying the stencil brush when it is not in use and three 5/16-in. holes are bored for the marking crayon, these being of different depths to allow for the wear of the crayon. Through a slot in the right-hand side a 32-in. straightedge is inserted behind the shield and is retained by a brass spring clip. On the left side of the box, on the outside, is a tin leaf secured by spring hinges at the bottom and fitted with clips for holding weight slips or other papers. As information is desired the leaf is turned down and the contents consulted. It automatically springs back into place as soon as it is released and the papers are thus secured safely without the attention of the workman.

The complete outfit weighs less than nine pounds, and is therefore no burden to the wearer. This design, of course, may be varied to suit conditions, although this style covers the essential points for the class of work involved.

DESIGN OF STEEL PASSENGER EQUIPMENT

BY VICTOR W. ZILEN

Associate, American Society of Mechanical Engineers

I

Theory and practice as applied to engineering have always seemed to be at variance. This is due to the consideration of one without due regard to the other; the backbone of successful designing lies in a thorough understanding of the relation between the two.

As a rule only the more essential parts of cars receive sufficient consideration from experienced designers, the details being left to beginners. Unfortunately, small details not cared for properly are likely to be a source of trouble from time the plans leave the drafting room until the construction is completed and from the time the car enters service until worn out, resulting in much friction between office and shops, endless correspondence, and in some cases investigations, tests and reports, without the cause ever being determined. A number of small items make big ones, and if the cutting of the weight of a car is essential, it can often be accomplished by cutting the weight of perhaps such things as coat hooks, hat racks, trim-

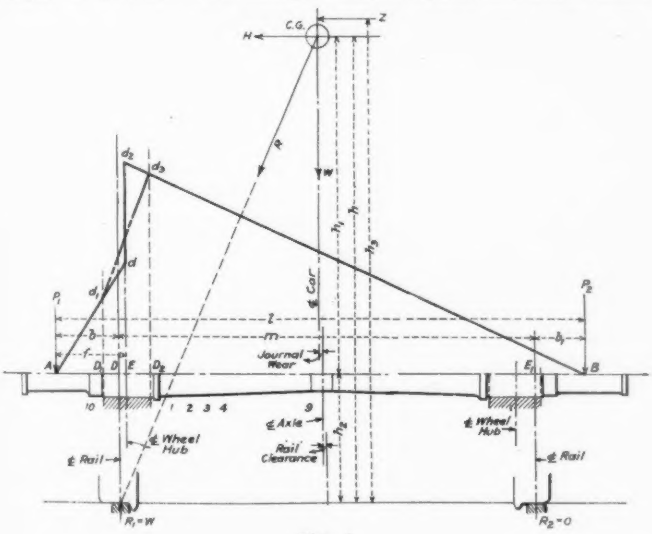


Fig. 1

mings, hardware, plumbing and heating fixtures, bulkheads, flooring, tables and seats and everything else that goes to make dead weight. The designer in charge must be a man whose judgment in passing on a design is final; he must have been in the same boat as the man who is to follow his blue print; he must be familiar with all the shop practices a workman has to contend with and must have had experience that will not permit him to mistake cantilevers and beams for columns and struts, or beams supported at the ends for those which are fixed at the ends; on such things depend largely the strength, weight and cost of the car.

Car construction does not belong to a class of work requiring refinement in machining and fitting of the various component parts, and outside of but few such parts the designer may keep clear of fancy blacksmith and machine work. Not all structural shapes can be worked cheaply in the forge shop; bending channels and angles requires skill and in some cases expensive dies and forms. Pressed sections, while they offer some advantages as to lightness and strength, are often at a disadvantage in making repairs by requiring high-priced labor. A simple pressed section may be used, but built-up sections of structural shapes and rolled bars are preferable.

AXLES.

In beginning this discussion of steel passenger car design, the writer wishes to take up the design of axles. The method of analysis of stresses in car axles which follows bears with it his acknowledgment of the vast amount of scattered information already available, and all credit is due to the authors of the work previously done. However, some axles designed by either of the generally known methods seem to indicate the advisability of revision and modification of the older formulas.

A general practice is to assume the center of gravity of the car as being six feet from the rail. Assume 26 per cent for vertical oscillation and add to the total vertical pressure on the axle; take 40 per cent of the total vertical pressure on the axle, including the 26 per cent for oscillation, and apply it at the assumed center of gravity of the car. On curves the 40 per cent acts horizontally, perpendicular to the direction of motion, and is supposed to just tip the car over.

But modern steel cars, having a heavy electric lighting equipment suspended underneath, together with heavy underframe construction, no doubt have their center of gravity much lower than six feet above the rail. On cars used in electric service, with heavy electrical equipment, the center of gravity is as low as 50 in. from the top of the rail. By this we see that it will take more than the 40 per cent of the load on the axle to tip the car over, and since it is acting horizontally it will produce an additional flange pressure, which, when multiplied by the radius of the wheel, gives a bending moment to the axle. (See Fig. 1.)

When a car is rounding a curve or passing over switches and frogs, it generates a force by virtue of its own weight and speed. This force acts horizontally and perpendicular to the direction of motion of the car and produces a lateral oscillation.

The force required to tip the car is a maximum when $R_1 = W$ and $R_2 = O$. Let the intensity of this force $= H$, and the height of its point of application above the top of the rail $= h$, we have for the moment M.

$$M = Hh \qquad (1)$$

Consider a wind action, Z, acting at its center of pressure above the center of gravity of the car, having for its lever arm the length $(h + x)$. The moment will be

$$M = Z\,(h + x) \qquad (2)$$

But, if the center of pressure is below the center of gravity of the car by an amount, x,

$$M = Z\,(h - x) \qquad (3)$$

The centrifugal force acting at the center of gravity of the mass considered, combined with Z, will tip the car over when the sum of their moments $=$ Hh,

Let C $=$ centrif. force

$h =$ the height of the center of gravity above the top of the rail. Then

$$M = Ch, \qquad (4)$$

Hence $Ch+Z\,(h+ -x)=Hh$ or $(C+Z)\,h=Hh + - Zx$

So that when the center of wind pressure is above the center of gravity we have from (1), (2) and (4).

$$(C+Z)h=Hh-Zx \qquad (5)$$

But if it is below, we have from (1), (3) and (4).

$$(C+Z)h=Hh+Zx \qquad (6)$$

From (6), we see that the worst condition is when the center of wind pressure is below the center of gravity of the car, as it shortens the distance h. In order to turn the car over, the horizontal force H will have to be greater, and since its reaction is at the rail it will give a bending moment to the axle.

Having shown how the intensity of the horizontal force H may vary the analysis of stresses in the car axle follows:

In Fig. 1, let $Z =$ the wind pressure,

$h =$ height of the center of wind pressure above rail,

$W =$ the total vertical pressure on the axle, including the weight of the lading and an allowance for oscillation.

$P_1 =$ vertical pressure on journal at A,

$P_2 =$ vertical pressure on journal at B,

R_1 and $R_2 =$ reactions at the rails,

$H =$ horizontal force caused by curves and switches,

$h =$ height of the center of gravity of the car above the top of the rail,

h_1 = height of the center of gravity of the car above the center of the axle,

h_2 = height of the center of axle above the top of the rail,

l = length of the axle between the points of application P_1 and P_2 of the total load W,

m = distance between the centers of the rails on curves,

$b = AD$ = distance from the center of rail to the point where the load P_1 acts on the journal.

$b_1 = E_1B$ = distance from center of the rail to the point where the load P_2 acts on the journal.

For the maximum conditions of loading, locate the center of gravity of the car and determine the center of wind pressure on the projected area of the car, on the vertical plane; if h_3 is less than h the effect of the wind should be considered; otherwise it should not. In this case, h_3 is greater than h, so h_3 will not be considered.

Taking moments about A we have for equilibrium of the car on the axle:

$$P_2 l = \frac{Wl}{2} - Hh_1, \text{ or } P_2 = \frac{W}{2} - \frac{Hh_1}{l} \quad \ldots\ldots (7)$$

$$\text{and, } P_1 = W - P_2 \text{ or } \frac{W}{2} + \frac{Hh_1}{l} \quad \ldots\ldots (8)$$

Also taking moments about R_1, we have for equilibrium of the car on the rails:

$$R_2 m = \frac{W}{2}(m - b + b_1) - Hh \text{ or } R_2 = \frac{W}{2m}(m - b + b_1) - \frac{Hh}{m} \quad \ldots\ldots (9)$$

Now $R_1 = W - R_2$; but from Fig. 1 we see that R_1 and H are maximum when $R_2 = O$; hence

$$R_1 = W \quad \ldots\ldots (10)$$

and by equation (9)

$$\frac{Hh}{m} = \frac{W}{2m}(m - b + b_1) \text{ or, } H = \frac{W}{2h}(m - b + b_1) \quad \ldots\ldots (11)$$

Now let x denote any distance from A along the axle; then we have for the moment M at any point from A to E, where x is less than f:

$$M = P_1 x,$$

$$\text{or from (8) } M = \left\{\frac{W}{2} + \frac{Hh_1}{l}\right\} x \quad \ldots\ldots (12)$$

From E to B, x is greater than f, but is less than $(l - f)$; therefore

$$M = P_1 x + Hh_2 - R_1 \cdot (x - b) \quad \ldots\ldots (13)$$

Or, reducing from equations (8) and (10) in (13),

$$M = \left\{\frac{W}{2} + \frac{Hh_1}{l}\right\} x + Hh_2 - W(x - b) \quad \ldots\ldots (14)$$

These formulas hold good regardless of whether f is greater or less than b.

Lay off on E, Fig. 1, the distance $E\ d$ = M by formula (12), to any scale; also lay off on E, the distance $E\ d_2$ = M by formulà (14), to the same scale. Draw Ad, dd_2, and d_2B. The abrupt jump at E is due to neglecting the length of the wheel hub from D_1 to D_2. Connecting $d_1\ d_3$ at the intersection of the bending moment diagram with verticals through $D_1\ D_2$ we obtain a graphic representation of the moments acting at any point on the axle, from which we can find the diameters for the corresponding points on the axle by the well-known formula

$$d = \sqrt[3]{\frac{M}{.0982\,S}} \quad \ldots\ldots (15)$$

In which d = diameter of axle in inches,

M = moment in inch-pounds,

S = fibre stress in pounds per square inch. According to Wohler's experiments upon the effect of repeated stresses in small bars 22,000 lb. is safe for axle steel. (Reference, Goodman; Mechanics Applied to Engineering; 1911, p. 637; also Master Car Builders' Proceedings, 1896.)

By scaling the vertical distance at any point on AB we can obtain the bending moment, direct, at that point, and by substituting the value of S in formula (15) we have for the diameter d at any point on the axle from E to E_1.

$$d = .07738 \sqrt[3]{M} \quad \ldots\ldots (16)$$

The diameter of the axle in the wheel hub from D_1 to D should correspond to the moment at D_2.

Formula (16) is applicable to all portions of the axle for strength, but in the case of journals running at considerable velocity, the freedom from liability to heat is at least as important as strength and a different method of calculation must be resorted to. Experience seems to indicate that for maximum static load a pressure of about 330 lb. per sq. in. of projected area on the journals is as high as should be allowed; the writer finds that in the limit of diameters of the M. C. B. axles, this pressure corresponds to an average of about 7,200 lb. per sq. in. stress in flexure. In obtaining these values for application to axles for passenger service, the M. C. B. Association standard axle loads, which are for freight service, have been reduced 10 per cent. (Reference, A. S. M. E., Trans., 1913, Vol. 35, p. 38.) Applying these values to the journals, we have for the diameter of the journals for strength, by formula (15):

$$M = .0982 d^3 S,$$

$$\text{or } \frac{Pk}{2} = .0982\, d^3 S, \quad \ldots\ldots (17)$$

$$\text{or } d = \sqrt{\frac{Pk}{2 \times .0982 Sd}} = .0266 \sqrt{P\frac{k}{d}} \quad \ldots\ldots (17a)$$

And for bearing surface,

$$p = \frac{P}{kd} \text{ or } P = pkd, \quad \ldots\ldots (18)$$

In which P = maximum static load on the journal,

k = length of the journal,

d = diameter of the journal,

S = 7,200 lb. per sq. in. stress in flexure for maximum static load,

p = 330 lb. pressure per sq. in. of projected area on the journal,

Now from equation (17)

$$P = \frac{2 \times .0982 \times 7200\, d^3}{k} = \frac{1414\, d^3}{k}$$

And from equation (18)

$$P = 330\text{ kd. Hence, } 1414\frac{}{k} =$$

$$330\text{ k d, or } 1414\, d^2 = 330\, k^2; \text{ and } \frac{k}{d} = \sqrt{\frac{1414}{330}} = 2.07.$$

Substituting this value of $\frac{k}{d}$ in (17a) we obtain after reduction

$$d = .0383 \sqrt{P} \quad \ldots\ldots (19)$$

And from equation (18):

$$k = \frac{P}{330\ d} \quad \ldots\ldots (20)$$

For an example, consider Fig. 1. Given the values l, m and h_2, allowance for journal wear lengthwise having been decided on and the distance between the center lines of the wheel hubs being known, required the limit for the diameter of the axle, the maximum static load per axle being 31,000 lb.

The distance which the center line of car is to one side of the center of the track equals the amount of journal wear lengthwise + the clearance between the wheel flange and the rail, in this case 1 in.; the height h of the center of gravity of the car is determined and an allowance of 26 per cent for vertical oscillation is made. In this case h = 65 in., m = 59.5 in., b = 9.25 in., b_1 = 7.25 in. and f = 10.1875 in. The length of the hub from D_1 to D_2 7 in., h_2 = 18 in., $h_1 = (h - h_2)$ = (65 — 18) = 47 in., and W = 31000 + 26 per cent = (31000 × 1.26) = 39060 lb.

From (12) we have for M, from A to E,

$$M = \left(\frac{W}{2} + \frac{H\,h_1}{l}\right)x, \text{ from (11) } H = \frac{W}{2h}(m - b + b_1).$$

$$\text{Then } H = \frac{39060}{2 \times 65}(59.5 - 9.25 + 7.25) = 17277 \text{ lb.}$$

For M at E, x = 10.1875 in. Then

$$M = \left(\frac{39060}{2} + \frac{17277 \times 47}{76}\right) 10.1875 = 308,000 \text{ in.-lb.}$$

and from (14) we have for M, at E,

$$M = \left(\frac{W}{2}\sqrt{\frac{Hh_1}{1}}\right) x + Hh_2 - W\ (x - b);$$

$$M = 308000 + (17277 \times 18) - 39060\ (10.1875 - 9.25) = 582,000 \text{ in.-lb.}$$

M, at D_2 = 550,200 in lb. by scale.

Then for d at D_2 by formula (16):

$d = .07738 \sqrt[3]{550200} = 6.341$ in., or 6 5/16 in. to the nearest sixteenth.

By the same method compute the diameter at any number of points as 1, 2, 3, etc., between D_2 and the center of the axle; M at 9 = 350,000 in. lb by scale, 1½ in. from the center of the axle, and the corresponding diameter; $d = .07738 \sqrt[3]{350,000} = 5.455$ in., or 5 7/16 in.

For the journal, compute the diameter by formula (19):

$d = .0383 \sqrt{P}$; $P = \dfrac{31,000}{2} = 15.500$ lb., maximum static load;

hence, $d = .0383 \sqrt{15,500} = 4.77$ in. as a limit.

And for the length k of the journal formula (20) should be used:

$$k = \frac{P}{330\ d} = \frac{15,500}{330 \times 4.77} = 9.85 \text{ in.}$$

From these calculations it is evident that a 5¼ in. by 10 in. journal should be used.

In these calculations no account was taken of the effect of brake shoe loads on the bending of the axle, as the height of the center of gravity of the car above the rail will give the maximum condition of loading the axle, which probably would never be equalled in service, except in the case of wrecks. The possibility of reaching the critical speed on curves, as well as for all the forces to act simultaneously, is remote; therefore this method of calculation may be considered safe. The clasp type of brake is rapidly coming into use, which does away with the unbalanced loads on the wheel, and consequently the effect of the brake shoe loads on the bending of the axle; but unfortunately, the effect of retardation at the rail on the bending of the axle cannot be done away with. Whenever such wheel sliding occurs the frictional force tending to rotate the wheel is at the rail, having for its reaction an opposite force at the journal bearing. The couple will give a bending moment to the axle in much the same manner as that produced by the brake shoe loads. This moment, however, will be in a direction perpendicular to the moment produced by the vertical loading, the resultant moment being M_r:

$$M_r = \sqrt{M^2 + M_1^2}$$

in which M is as before, and M_1 is the moment caused by the couple.

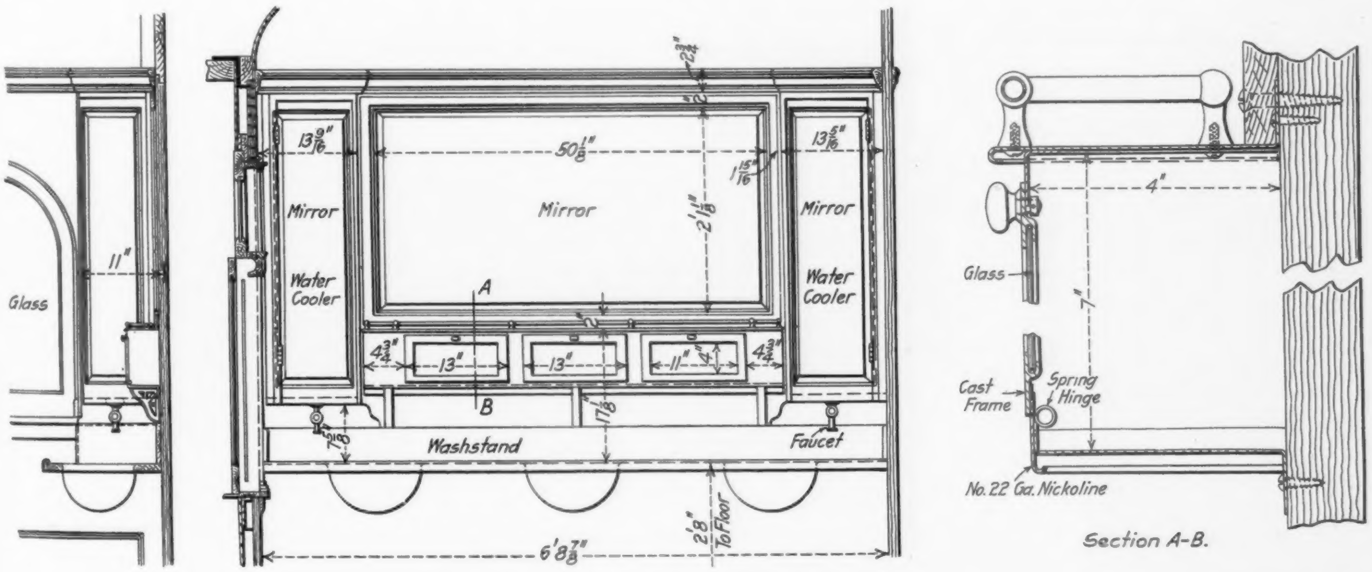
In addition to the combined vertical and horizontal bending there is also torsion in the axle, produced by the friction of unequal wheel load on the rail. It was shown by Fig. 1 that $R_1 = W$, and $R_2 = O$. Now in the case of a wheel sliding, the friction force at the rail tending to rotate the wheel at R_1 is much greater than that which the brake shoe on the same wheel can resist. The wheel would actually turn had it not been for the brake shoe on the wheel at R_2; the result is torsion in the axle between the wheels. For motor truck axles the effect of the weight of the motor and motor traction, is to be added or deducted, as the case may be, from the moment found by formulas (12) and (14).

The term "wheel sliding" is here used for the sake of clearness only; it should be understood that retardation at the rail gives a bending moment to the axle even though no wheel skidding actually takes place.

The speed of a train on curves is limited by the stability of the cars on the rail and knowing the actual average height of the center of gravity of cars in passenger service, the design of axles, if made to correspond, will increase the permissible speed of trains on a given degree of curves, without encroaching on the safety of passengers. In steam service, this point involves, also, the stability on rails of the locomotive, which will, no doubt, continue to keep pace in this regard with the requirements of modern steel cars.

TOWEL RECEPTACLE FOR SLEEPING CARS

When towels are placed in the overhead racks ordinarily used in the toilet rooms of sleeping cars they are likely to collect more or less dust and become saturated with the odor of coal smoke. In order to avoid this, the Canadian Northern is using in its sleeping cars a closed receptacle for towels, as shown in the engraving. This is of metal construction, with glass doors in front, and is placed directly over the wash basin in the toilet rooms so as to be most convenient for passengers. The doors are provided with spring hinges so



Closed Receptacle for Clean Towels in Sleeping Cars

that when they are released they will close automatically.

This towel cupboard was developed in the office of A. L. Graburn, mechanical engineer of the Canadian Northern, Toronto, Ont.

NORFOLK & WESTERN HUMIDITY-CONTROLLED DRY KILN

BY W. H. LEWIS
Superintendent Motive Power, Norfolk & Western, Roanoke, Va.

A dry kiln has been recently put in operation at the Roanoke shops of the Norfolk & Western, embodying features worked out in recent government investigations into the principles of the kiln drying of lumber. The kiln represents the direct results of the experiments of the United States forest products laboratory at Madison, Wis., the staff of this laboratory acting with the mechanical department of the Norfolk & Western in designing the kiln and its equipment.

The general principles of drying are based on what is known as the humidity-control system. It was found by the Forest Products Laboratory that the maximum rate at which moisture should be removed from the surface of lumber at any temperature is not greater than that at which it will be drawn through the fibres of the wood to the surface. The only practical way of controlling such evaporative speed is by controlling the humidity of the current of air passing over and through the lumber; hence the term "humidity-control," as applied to this kiln.

The kiln is unique in that it has no stack and no regular air inlets or outlets. The same heated air is used over and over and the moisture is removed from the air by means of a spray of water which lowers the temperature of the air and causes precipitation of the moisture, the same as natural precipitation of rain in external air; thus the only discharge from the kiln is a small stream of water.

The kiln consists generally of a drying chamber with air legs or spray chambers at either side and with a heating chamber immediately under the drying chamber. The air passes over a bank of steam pipes which are located just under the loads of lumber. The heated air rises and passes through the stacked lumber to the top of the kiln. Along the top of the air legs are spray nozzles which by means of a fine mist of spray chill the air at the top of the kiln, causing it to drop by gravity down the air legs to the bottom of the kiln, where it again comes in contact with the heated steam pipes, thus performing continuous cycles. As the heated air passes through the stacks of lumber the moisture from the lumber is taken up by the air and when this air is chilled at the top of the air legs the excess moisture is precipitated and mingles with the water from the spray nozzles.

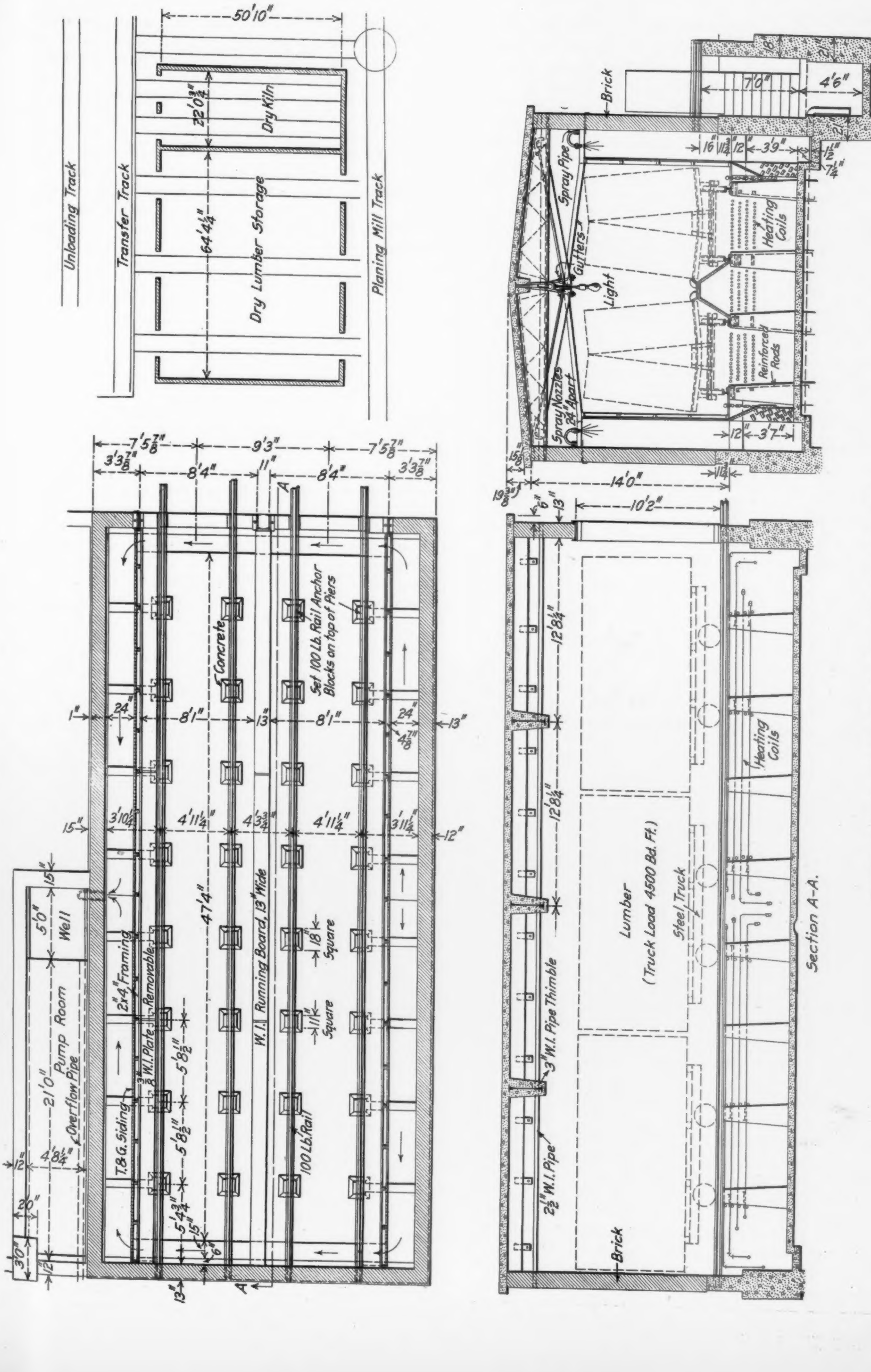
Thermostats are provided for regulating the amount of steam to the steam pipes, by which means the temperature of the drying chamber is controlled, and further means are provided for controlling the temperature of the spray water, by which means the temperature and humidity of the air before it reaches the steam pipes are controlled. The spray water is circulated by means of a suitable pump, so that this water is used over and over, an overflow being provided so that excess water will drain off to the sewer.

The kiln is susceptible of very delicate control, and by controlling the humidity of the drying air the speed of drying may be regulated to a nicety. By this means the most rapid consistent rate of drying may be attained without injuring the lumber.

In connection with this kiln there has been provided a dry lumber storage building so that the kiln itself may be of smaller dimensions and kept in continuous use. The kiln is built at one end of the storage building and a transfer car runs on a suitable track along the front of the buildings. The lumber or kiln cars run into either the kiln or the storage building from the transfer car. The location is convenient to the planing mill.

Lengthwise piling of the lumber is used in the kiln, and the kiln cars are of steel and not of the customary knockdown type.

Front View of the Norfolk & Western Dry Kiln



Details of Construction of the Norfolk & Western Dry Kiln

A peculiar method of piling the lumber on the car is used, as shown in the illustrations. A tapered central channel is formed for the upward passage of the air, and the strips between the layers of lumber form slightly upward inclined air passages. By this means the current of air passes uniformly through the entire stack of lumber, and uniformity of drying is obtained.

The clearance dimensions of the drying chamber are as follows: Length, 50 ft. 10 in.; width, 17 ft. 3 in.; height, 10 ft. 2 in.

The kiln holds six kiln cars of lumber, the capacity being

Interior of Humidity Controlled Dry Kiln

approximately 27,000 board feet of 1-in. material. It is supplied with approximately 3,300 sq. ft. of heating surface. The building is of brick laid in cement mortar; the foundations and pipe chamber are of concrete, while the roof is of cinder concrete.

This kiln has been in successful operation drying all kinds of lumber for some time and fully meets the expectations of the designers. A number of patents on the principles involved have been issued to Harry D. Tiemann, of the Forest Products Laboratory, all of which have been dedicated to the public.

THE VENTILATION OF SLEEPING CARS*

BY THOMAS R. CROWDER, M.D.

Director of the Sanitation Department of the Pullman Company

Perhaps the time has not yet come when we can say that fresh air is thoroughly understood. But we can certainly say with safety that popular conceptions concerning it are very erroneous. It is still commonly held that out-breathed air contains a volatile poison, and on this erroneous assumption have been developed the theories which have controlled the practice of ventilation almost up to the present time. There can of course be no doubt that the air confined in crowded places may become harmful through changes brought about by the people using it, and that it needs to be frequently renewed. The necessity for ventilation is beyond question, but does not arise from a poisoning of the air by the products of respiration.

The air which surrounds the body has two principal functions: a chemical and a physical. It oxygenates the blood and it removes the body heat. For the performance of its chemical function it must contain a sufficient amount of oxygen to keep the hemoglobin saturated and be free from poisonous gases; for the performance of its physical function it must be cool enough to absorb the heat of the body, dry enough to take up moisture from the skin, and have motion enough to carry away the aerial envelope to which this heat and moisture are transmitted. If the air of the room is not renewed its oxygen is gradually consumed and it becomes laden with heat and moisture from the bodies of the occupants. In this way it may finally become unable to perform either of its principal functions. A constant supply of fresh air is therefore necessary. But careful experiment has demonstrated that under all ordinary circumstances the fault develops on the physical side so far in advance of the chemical that the latter may be practically left out of consideration. Relatively small amounts of fresh air will always supply the chemical needs of the body; large amounts may be necessary to supply the physical demands. Granted that the small amount of air necessary for the demands of respiration is supplied, the control of its physical properties becomes the great problem of ventiltaion; and of these physical properties temperature is vastly the most important. The success of ventilation depends far more on supplying conditions suited to the outside of the body than to the inside of the lungs.

But if the accumulated evidence of physiological studies has taken from us the old basis of chemical purity as a guide to ventilation standards, it has at the same time pointed the way to a new and more logical basis existing in the physical properties of the air. It has demonstrated that the discomfort and physiological disturbance experienced in badly ventilated rooms is due to the heat, the humidity and the windlessness of the air which render it incapable of cooling the skin at the normal and necessary rate.

An ordinary adult will produce—and must be relieved of—enough heat in the course of an hour to raise the temperature of a thousand cubic feet of air by 15 or 20 deg. F. The air with which the body is either directly or indirectly in contact must take away this heat. Herein lies the basic equation of the ventilator's problem. When many people are crowded together in a small space they very soon overheat the air, and its depressing effect is added to by its stillness and by the moisture exhaled with the breath. More air and cooler air must be supplied; fresh air becomes an imperative need. But here I would emphasize that the quality we generally recognize as "freshness" does not depend on richness in oxygen, nor on the absence of carbon-dioxide and organic poison, but on the ability of the air to remove the body heat. Fresh air is air that will cool the body more rapidly. Failing in this, no property, either physical or chemical, will make it "fresh." Coolness of the air is more important than its content, and agitation is of greater significance than its purity. It follows that the impulsion of hot air into a room is the most objectionable of all systems of ventilation, while cool air and radiant heat approach the ideal.

But changing our scientific basis for ventilation does not necessarily mean that we must entirely desert all quantitative standards in actual practice. We must not expect the body to transmit its hundred calories per hour to a hundred cubic feet of air, though a hundred cubic feet may fully supply the demands of respiration. For the body at rest and with ordinary indoor clothing, there are sharp limitations to the physical conditions that will maintain the sense of well being. Within a range of temperature compatible with comfort it will require something like 2,000 cu. ft. per hour to absorb the heat of an ordinary adult, unless the heat transmitted to the air is rapidly abstracted from it. Curiously enough, this figure corresponds closely to that arrived at long ago as the air supply necessary to maintain

*Portion of a paper presented before the annual meeting of the Society of Heating and Ventilating Engineers, Jan. 1915.

the requisite degree of chemical purity. The suggestion is forced upon us that the old standards were really, though not consciously, based on thermic considerations after all, for carbon-dioxide is a guide to quantitative interchange as well as to chemical purity. But on the old basis, more air was the universal remedy for ventilation troubles—more air in order to lessen respiratory contamination—and it often failed to effect a cure. On the new basis, cooler air, or dryer air, or more motion—all of which facilitate the transfer of body heat, and none of which necessitates an increased supply—are the measures indicated; and through a proper combination of these remedies relief should be obtained.

It is now seven or eight years since I began to study the ventilation of sleeping cars and to attempt a solution of the vexed question concerning the best methods for producing comfortable and hygienic conditions in them. In common with most people I then believed these cars had a very inadequate air supply. As we now understand the subject, it must be admitted that the cars were poorly ventilated, and that the air supply was sometimes small, but faulty ventilation did not usually lie with an insufficient volume of air. Other faults were much more frequent, and chief among them was artificial overheating.

When my studies were begun the almost universal plan of ventilating railway cars was to introduce fresh air by opening small windows at the top of the car which are usually referred to as deck-sashes. Sometimes large volumes would enter through these openings, sometimes little or none, and sometimes they would act as outlets only. With changes in the direction of the train or the wind these various actions would alternate. The openings being large, when they became active intakes, uncomfortable downward draughts were produced; when they ceased to act as intakes the total air supply would be much restricted and overheating would be readily brought about. The result of this plan was that ventilation was very irregular, that an adequate air supply could not be depended upon, and that comfortable or hygienic thermic limits could not be continuously maintained.

A little experimentation soon demonstrated that sufficiently large volumes of air for all the practical purposes of sleeping car ventilation will, under certain circumstances, enter the car end a device was applied to the roof of the car which utilized the power supplied by train momentum to produce suction, thereby drawing air out through the deck-sashes formerly used as intakes.

The purpose aimed at was well achieved. The result was as contemplated. The average air supply was much increased and the flow regulated. Perfect regularity of air supply was not realized; but it is one of the fallacies of general opinion concerning ventilation that perfect regularity of air supply is desirable. It has been pointed out by Leonard Hill that one's comfort depends in a vast degree on the stimulation of a changing physical environment—that it is due to the ceaseless variation of the temperature and motion of the surrounding air. In this light irregularities of air supply and air temperature become of great importance, but they should not vary beyond the limits within which comfort lies.

The objection is sometimes raised that simple exhaust ventilation, without the provision of inlets, cannot possibly furnish to railway cars a sufficient air supply. I, too, was originally of that opinion; but so far as the requirements of sleeping cars are concerned it was a mistaken opinion, as has been amply demonstrated. The quantity may at times be quite astonishing. I have measured up to 30,000 cu. ft. per hour passing out through the ventilator duct from a small stateroom with the door and windows closed, and when, therefore, the air had to find its way in through crevices. Much of it came from the adjoining passageway, through the freeway under the door. Natural crevices are sufficient air inlets if properly utilized, and they possess a vast advantage over larger openings. The incoming jets of cold air are individually so small, and they take on such irregular motions in mixing with the stiller air within, that all the good effects of variegated temperature and motion are obtained without the disadvantages of uncomfortable cold draughts.

If a few large inlets are used and the weather is cold, the incoming air must be pre-heated. Pre-heating has its drawbacks, but it is necessary for most heavily occupied places. If sufficient crevices are available, and the occupancy is not too great, pre-heating may often be dispensed with. Few enclosures are so richly endowed with crevices as is a railway car; no other place is so constantly subjected to high winds, which cause crevices to let in outside air whether we will or not. In entering, these cold jets meet the warm stream flowing upward past the windows and the mixing begins at once, as it should. But whereas these crevices act irregularly, and in the main inefficiently, as air intakes when unaided, they act efficiently and with a sufficient degree of regularity when assisted by exhaust ventilators located at the top of the car.

Of course, we cannot directly measure the amount of air flowing into a car through its many crevices. But we can

CONDITIONS				AIR SUPPLY CUBIC FEET PER HOUR
TYPE OF CAR	METHOD OF VENT-ILATION	END DOORS	DECK-SASHES	0 – 10,000 – 20,000 – 30,000 – 40,000 – 50,000 – 60,000 – 70,000
WOOD	NATURAL OR DECK-SASH	CLOSED	CLOSED	18,500
			OPEN	28,300
		OPEN	CLOSED	32,600
			OPEN	40,700
	EXHAUST	CLOSED	CLOSED	40,600
		OPEN	CLOSED	57,900
STEEL	EXHAUST	CLOSED	—	53,000
		OPEN	—	65,900

Fig. 1—Methods of Ventilating Sleeping Cars Compared*

through the several hundred feet of crevices about doors and windows. Thanks to the imperfection of the car builder's art, it has not been found possible—though much pains have been taken in trying—to build a railway car so tight but that much leakage may take place. When this occurs the air of the car remains relatively pure, heat does not accumulate, and comfort is maintained. It was therefore deemed advisable to utilize these crevices as air intakes and to attempt their regulation by providing a constant forced exhaust from the top. To this

*801 observations in 183 cars.

measure the outflow through the ducts of exhaust ventilators, and we know the one must equal the other when only crevices are available as inlets. We can also estimate the air interchange by determining the proportion of carbon dioxide in the inside air and counting the number of occupants concerned in producing the contamination. Both these procedures have been carried out. By the former it has been demonstrated that the ventilators now almost universally installed on Pullman cars will each discharge from the running car some 12,000 or 15,000 cu. ft. of air per hour. Six are applied to the twelve-section body of the standard car, and they all work constantly, though not at a constant rate.

But determining the outflow of air records only a minor fact. Without a study of the entrance, the distribution, and the interchange in the zone of occupancy it remains of little value. Herein lies the necessity of learning the carbon dioxide content of the air. It enables us to determine these things, and it must always be a part of any adequate study of air conditions. On it we may base also reasonably accurate estimates of total air supply; but it should be kept in mind that

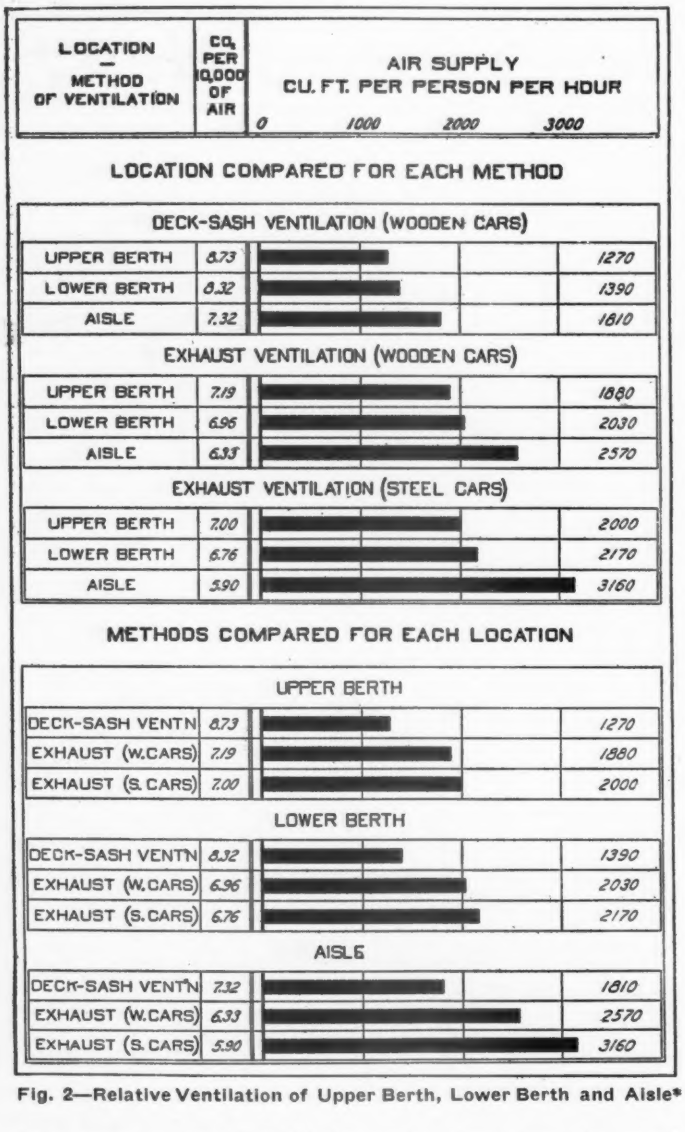


Fig. 2—Relative Ventilation of Upper Berth, Lower Berth and Aisle*

estimates so made will fall below rather than above the actual.

A fairly extensive study of carbon dioxide in the air of sleeping cars has been made, the details of which have all been reported in other places. We may refer here to a few general averages only which will be recorded in the form of charts.

In Fig. 1 are represented the average air supplies, as determined from the carbon dioxide in the breathing zone, while cars were running in regular service at ordinary speeds and with various possibilities as to air inlets and outlets. The significant bars of the chart, representing cars where no intakes in addition to crevices were provided, are the first, fifth and seventh. Unaided by exhaust ventilators the average air supply through crevices alone was only 18,500 cu. ft. per hour; aided by exhaust ventilators the averages were 40,600 and 53,000 cu. ft. per hour for wooden and steel cars respectively. The difference between the latter two is believed to depend on the almost total absence in the steel car of crevices in its upper portion by reason of the absence of deck-sashes and a consequent absence of short-circuiting of air currents from deck-sash crevices to ventilators necessarily close at hand. There is in consequence a more constant withdrawal from below, and a more rapid changing of the air of the lower levels. The average occupancy of the cars represented in Fig. 1 was about fifteen people each, from which it follows that there was considerably more than 2,000 cu. ft. of air per hour for each occupant in the cars equipped with exhaust ventilators, while there was only about 1,200 cu. ft. per hour for each occupant in those not so equipped. Since the figures apply only to the 12-section sleeping car body, the practical maximum occupancy is about 25 people.

In Fig. 2 are shown the relative average air supplies per person, as determined by the carbon dioxide content, for the upper berth, lower berth and aisle of cars ventilated by open deck-sashes, and of wooden and steel cars ventilated by the exhaust method with only crevices as inlets. All berths were occupied by one person each, and each group of cars contained an average of about 16 people. The air supply is seen to be considerably larger with the exhaust type of ventilation; and it is sufficient to meet the physical as well as chemical demands placed upon it. Not only is the average volume of air supplied to berths increased by the exhaust method of ventilation, but the flow is more regular and is more constantly maintained.

It seems beyond question that a great improvement has been made in the ventilation of sleeping cars by the adoption of the simple exhaust method, and that the results are on the whole quite satisfactory. Carbon dioxide never rises so high—it is rarely as much as 10 parts in 10,000—as to indicate an air supply insufficient for the needs of the body; the supply of air is reasonably uniform, while the innumerable eddies caused by minute incoming streams of cold air striking the warmer air within bring about thorough mixing and good distribution without destroying the ceaseless small variation so essential to continued comfort. The possibility of overheating still remains, and must always remain with any system of car ventilation, as a matter requiring intelligent attention. But the assurance of a constant and fairly regular supply of cool air from without makes it a much less probable occurrence, while changes in car-heating plans and simple instructions to car operators concerning the significance of thermometers have also aided greatly in remedying the evil.

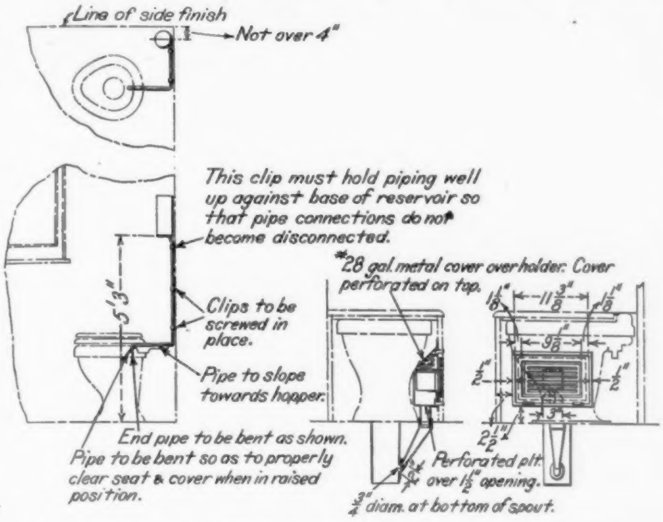
DISINFECTANT ARRANGEMENT FOR PASSENGER CARS

Considerable trouble has been experienced in maintaining drip disinfectant devices in working order because of the loss of the piping. The reason for this is that the connecting nipple on the base of the reservoir is turned away from the finish, thus allowing the supply pipe to project out where it is liable to damage. The only supporting medium under these conditions is a single clip immediately underneath the reservoir. The drawing shows an arrangement with the tank placed in the corner of the saloon and allowing the piping to pass close to the finish for its entire vertical length and laterally to a point directly in the rear of the hopper. It is thus possible to securely clamp the pipe for its entire length.

At the right side of the drawing is shown the arrangement

*2746 observations in 130 cars.

of the vapor type of disinfectant in the enclosed hoppers used in sleeping car compartments and private cars. The ventilating arrangement prevents the accumulation of odor from the disinfectant cake from flooding the room when the hopper cover is



Arrangement of Disinfectant Holders in Passenger Cars

raised. The excess odor from the disinfecting cake is carried out through the funnel. This arrangement is in use on the Canadian Northern and was designed by A. L. Graburn, mechanical engineer of that road.

CAR ELECTRIC LIGHTING SYSTEMS

The following is taken from an article by E. S. McNab, inspector of electric car lighting, Canadian Pacific, appearing in the June, 1915, Railway Electrical Engineer.

The problem of lighting passenger equipment by electricity is comparativly new on this continent, although in Europe and the British Isles it has been the practice for about twenty-five years. However, the rapid increase in the number of equipments applied in North America, during the last few years, has, to a great extent, compensated for the relatively late start.

In 1911 the Canadian Pacific Railway had only 68 electric lighted cars, whereas this figure has now been increased to 380, which includes 100 per cent of the compartment sleepers and observation cars, 85 per cent of the modern sleepers and 60 per cent of the total number of diners; the remaining gas-lighted cars of these classes are being converted as the cars receive general repairs. Large increases which have been made on the Pennsylvania, New York Central, and New York, New Haven & Hartford are probably due to the tunnels by which they enter New York City, gas or oil lighted cars not being permitted to enter either of these terminals.

I will divide the methods adopted in lighting cars by electricity into three main systems, namely, the straight storage system, the head end system, and the axle system.

The equipment for the straight storage system consists of a set of storage batteries contained in battery boxes under each car, the batteries being connected to the lamps by the usual wires and controlled by a single switch or switches. This is certainly the simplest method of lighting, but when we investigate its methods of operation we get into difficulties.

In the first instance, the batteries have to be charged at each terminal, or at least after every eighteen to twenty-four hours of lighting, which necessitates the car being held in the terminal yard for a period of from six to ten hours, depending on the condition of the batteries on arrival.

It is interesting to note that at one of the New York yards 350 outlets have been installed, each outlet having a separate pair of wires back to the switchboard in the power house, No. 8 cable being the smallest size used. Power is obtained from three 250-kw. motor-generator sets, giving 110 and 220 volts. The switchboard arrangement is also considerably complicated due to the large number of individual circuits which have to be controlled.

It is interesting to note in passing that an attempt has been made to reduce the lengthy period of charge by increasing the charging rate by the use of the Wilson battery. This battery is so constructed that it can be charged at 1,000 ampere rate for a short period, but, as is apparent, this high rate involves specially heavy charging cables throughout the yards, and also special fittings on the cars. It has been adopted to a limited extent on the Erie Railroad on its suburban trains, but its non-adoption by any of the other roads indicates that its disadvantages overbalance its advantages.

The head end system, as its name implies, consists of a steam driven generator in the baggage car, located as close to the locomotive as possible. This system is in use on most of the roads running west of Chicago, and on "limited" or solid trains gives good service. The equipment consists of a 20 or 25 kw. turbo-generator located in the baggage car, driven by steam from the locomotive; a control switchboard is installed from which three main cables run overhead throughout the trains. As the turbine must necessarily be stopped during change of engines or while standing in a terminal before the locomotive is coupled up, it is therefore necessary to install a certain number of storage batteries on the train which will carry the lighting load during the above-mentioned periods.

It is the Northern Pacific practice to install 200 ampere-hour batteries on the postal car, dynamo car, standard sleepers and observation car on each train. On most of the roads using this system the baggagemen are trained to operate the electrical equipment, and after showing a certain proficiency by means of examinations, receive higher pay. I am advised by several of the electrical engineers that these men are giving satisfaction; some roads, however, still continue to employ train electricians.

The chief disadvantage of this system is the want of flexibility, and this is felt where trains have to be remarshalled at junctions and cars switched off on branch lines; this leads to the necessity of equipping a large proportion of the cars on every train with batteries, increasing the capital and maintenance costs. Another disadvantage is the high steam consumption which the turbine accounts for, and our experience in Canada points to considerable difficulties from this source during the winter months should this system ever be tried.

The axle generator system comprises a generator driven by means of a belt from the axle and a set of storage batteries which supply current to the lamps when the train is at rest. As this equipment is applied to each car it follows that it is an individual unit and can be transferred to any line in any class of service without any adjustment of the apparatus being necessary.

The design of an axle device involves the overcoming of five problems: (1) The reversal of polarity, due to the change in direction of rotation of the armature when the car reverses the direction in which it runs; (2) the maintenance of a constant output in watts or horsepower, irrespective of the speed of the train after the generator reaches its maximum, which is 22 to 25 miles per hour; (3) the lamp voltage must be held constant at the normal voltage, which is 30 in the United States, and generally 24 in Canada, while the generator is running at a voltage of 40 in the United States and 30 in Canada; (4) the batteries must receive a sufficient charge to replenish the loss of current consumed at terminal stops, but at the same time must not be overcharged; (5) an automatic arrangement must connect the generator to the batteries when

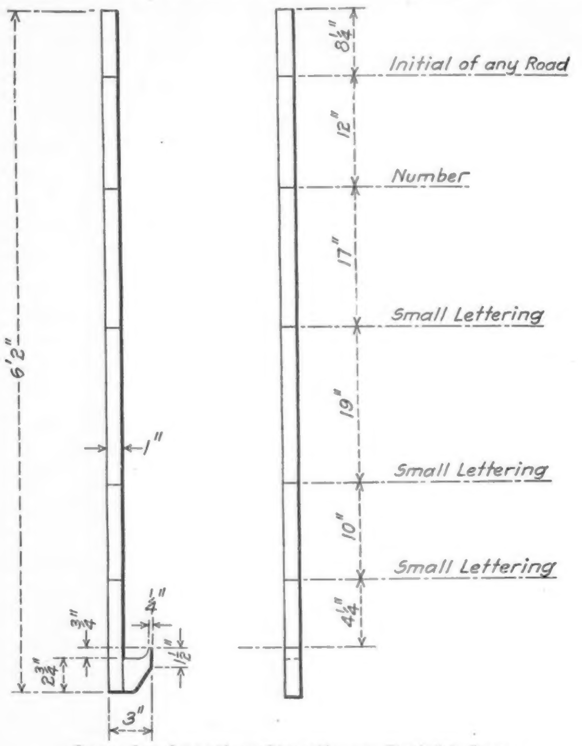
the speed of the train is such that the generator voltage is equal to the battery voltage, and disconnect them when the speed falls below that point. To meet the foregoing conditions there are about a dozen patent systems in use in Europe. None of these have ever been adopted in this country, with the exception of the Stone System, which is extensively used in Canada. In the United States there are five principal systems, namely, the Safety, Gould, Consolidated, United States, and the E. S. B.

STENCILING GAGE FOR FREIGHT CARS

BY W. F. JAMES

Foreman Painter, Atlantic Coast Line, Rocky Mount, N. C.

The accompanying illustration shows a very simple, inexpensive wooden stencil gage. The lower end of this gage is provided with an offset point which bears on the under surface of



Gage for Locating Stencils on Freight Cars

the side sill, providing a much more accurate method of gaging the lettering than by using the bottom of the sheathing or siding. Much better results have been obtained with this device than with any other so far used.

UNIFORMITY IN CAR INSPECTION*

BY M. MAREA

General Superintendent, St. Louis, Troy & Eastern, St. Louis, Mo.

I will take up this question in three sections: (1) Interchange points, (2) Delays to cars, and (3) Need for greater co-operation between car departments throughout the country.

The inspection of cars at interchange points is of more than ordinary interest. It is the problem which confronts inspectors and car foremen today and which requires men of more than ordinary ability to solve. A good car inspector is one of the most valuable assets that a car foreman can have, and a car foreman is the most valuable asset that any railroad can have, if he is capable of passing judgment on the cars that are to run upon his rails. The latter is a question which may not seem important, but it is of vital importance from an operating standpoint.

*From a paper read before the Car Foremen's Association of St. Louis.

Not only is the inspector responsible for the condition of the cars, but he makes his company responsible to the shipper for the delay to the freight that is contained in the car which has been shopped. This reverts back to the traffic department, which has spent many hours and probably days of hard work to secure the shipment. Consequently, the inspector must be a man of more than ordinary intelligence, must use good judgment and not hold a car for repairs if it can safely be moved forward. I have found that the source of the greatest trouble between car inspectors and car foremen lies in trying to "get even with the other fellow." This is decidedly wrong. An inspector must be fair and honest with his own company and also with his delivering line, and not shop for repairs any car which in his judgment can go forward. Of course some mistakes will be made.

Too many cars are being delayed by inspectors because certain visible defects exist which apparently justify them in sending the cars to the transfer track. This is frequently because the car department has been allowed only a certain amount of money and the foreman in charge feels that he has not money enough to make the repairs; the car is therefore marked for the transfer track and a claim made for defects. If the claim is cut by the chief interchange inspector, the contents are nevertheless transferred and the car is returned to the delivering line. The delivering line, in 99 cases out of 100, loads the car without repairs being made and it starts forth in a different direction and carries its contents through interchange points safely and without complaints being received from three or four of the interchange points through which it passes.

Now if the car department were charged with the cost of the transfer, the per diem of the load and empty, as well as the damage to the contents, the transfers of to-day would, I dare say, decrease 75 per cent. because of placing the responsibility where it actually belongs. You may wonder why I make such a broad assertion; but the car department is wholly responsible to the operating and traffic departments for the furnishing of equipment that is in safe and serviceable condition to move whatever commodity it is desired to place therein. If the car gets in bad order through unfair usage the car department is not responsible.

The car departments throughout the country are not working close enough together and are not using what may be called a broad and liberal interpretation of the M. C. B. rules of interchange.

Electric Iron Furnace.—Pig iron production by means of the electric furnace is carried on at Tinfos, Norway. Coke is used as the reducing material and the ore carries 44 to 47 per cent iron. The power of the furnace is from 1,200 to 1,400 kilowatts. There are four furnaces at Tinfos, three being usually in operation, while one is held in reserve. The output is about nine tons per furnace per day.—*The Engineer.*

New Nitrogen Factory in Norway.—At the Bjölva waterfall, Norway, a new factory is to be erected for the manufacture of sulphate of ammonia and cyanamide. Arrangements have already been made to dispose of the output of the latter production for a period of five years. The annual output of sulphate of ammonia will be about 6,000 tons. The matter is being supervised by a committee of four experts, who are at present in Sweden in order to study the new method of manufacture.—*Engineering.*

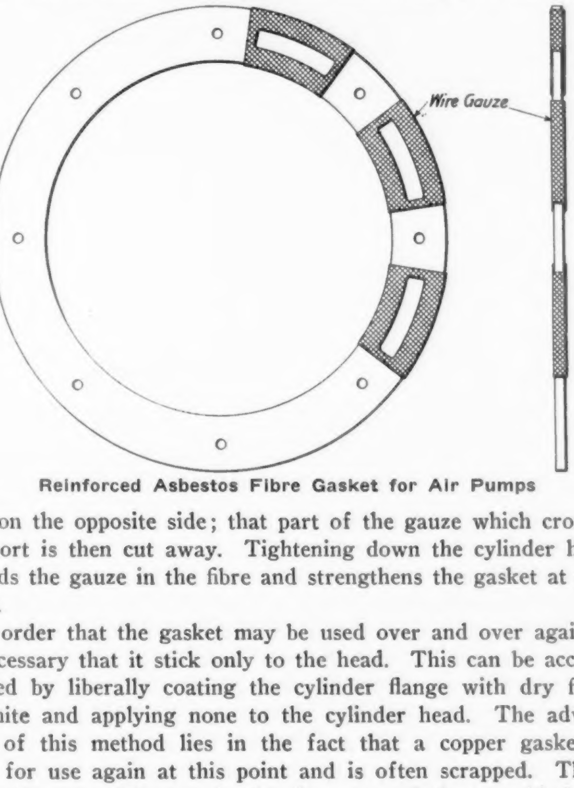
Summer School of Scientific Management.—The Pennsylvania State College, State College, Pa., conducted a summer school of scientific management during the two weeks beginning August 9. This summer session was planned for the accommodation of works managers, superintendents, heads of cost, stores, purchasing, planning and productive departments, and members of such departments. The time was restricted to two weeks to meet the needs of employees whose vacation period was limited to that time.

SHOP PRACTICE

REINFORCED ASBESTOS GASKETS FOR ALL PUMP CYLINDER HEADS

BY J. A. JESSON

A method of reinforcing asbestos fibre gaskets for use on 9½ in. air pumps, that renders them immune to blow outs or leakage around the steam ports so common with copper gaskets is shown in the drawing. A piece of ordinary wire gauze such as is used in passenger car ventilators is wrapped around one side of the gasket with its ends extending as far as the edges of the steam port on the opposite side; that part of the gauze which crosses the port is then cut away. Tightening down the cylinder head embeds the gauze in the fibre and strengthens the gasket at this point.



Reinforced Asbestos Fibre Gasket for Air Pumps

In order that the gasket may be used over and over again it is necessary that it stick only to the head. This can be accomplished by liberally coating the cylinder flange with dry flake graphite and applying none to the cylinder head. The advantage of this method lies in the fact that a copper gasket is unfit for use again at this point and is often scrapped. There is hardly any difference in the first cost of the two kinds of gaskets.

AN ELECTRIC PROCESS FOR SAFE-ENDING TUBES

BY L. R. POMEROY

The Norfolk & Western is using an electric welding process for safe-ending tubes at its Roanoke, Va., shop. The arrangement of the machine and the grouping of the equipment is shown in the engravings.

In Fig. 1, Clamp No. 1 is fixed to a table, while Clamp No. 2 is designed for horizontal movement by means of a toggle operated by a lever. By means of this the safe end, *A*, is pressed hard against the tube *B*, so arranged that an electric circuit is made, the switch being closed by the lever, simultaneously with the contact of the safe-end *A* with the tube at *B*. The air cylinders on both clamps operate a movable jaw, gripping and firmly holding the tube and safe end. The wings of the clamps are cored out and provided with water circulation, to rapidly dissipate any heat caused by the welding heat.

The welder, Man No. 1, Fig. 2, operates the electric welding machine, the helper, Man No. 2, cuts off the scored ends of the tubes and places them in Rack No. 2. In operating the machine the welder places the safe end in Clamp No. 2 and at the same time the helper places the cut off end of the tube to be welded in Clamp No. 1. The welder then forces the safe-end against the tube by means of the lever which operates the toggle, and when the contact is made the electric circuit is closed, the contact surfaces coming up to a welding heat almost instantly. When complete the helper removes the welded tube to the roller, and while the tube is being rolled smooth on the outside by the rolls under spring pressure, and by the mandrel on the inside, another tube is inserted in the electric welding machine. The rolling operation seems hardly necessary, as the tube leaves the welder in a condition fit for service, and we are told the rolling operation is simply a precautionary measure against any roughness or fins that may possibly arise. The final result is a tube so smooth and regular that the line of the weld is hardly visible to the eye and to all appearances the tubes so safe ended can hardly be distinguished, save perhaps by color, from new ones. The tubes and safe-ends are not scarfed; the operation therefore is what is called butt welding, in contradistinction to scarf welding, when the tube is belled out and the safe end scarfed and stuck in the belled mouth of the tube.

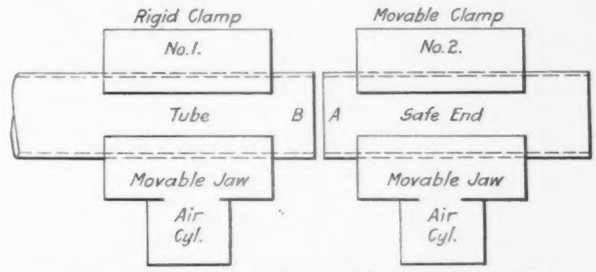


Fig. 1—Clamp for Holding Tube and Safe End

The complete operation of welding and rolling, as timed by stop watch, occupied just 20 seconds per tube, or 3 tubes per minute, which is equal to 180 per hour—or, allowing for contingencies, say 100 per hour. At this rate, one machine and two men would weld enough tubes per day to complete two boilers, or as fast as the most modern type of cleaning machine can prepare the tubes.

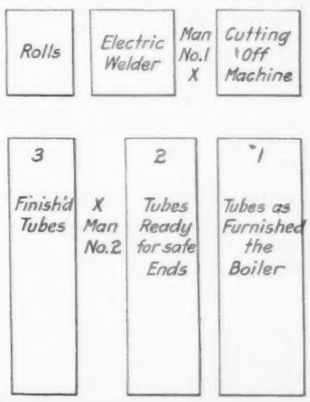


Fig. 2—Grouping of the Equipment

The electric welding machine is operated by alternating current through a transformer, the primary voltage of which is 220 volts, and the ratio of the transformer reduction about 44 to 1. The transformer is rated at 35 kw. With electric current at 5 cents per kw.-hour the cost per tube, rating the welder

and helper at 50 cents and 35 cents per hour respectively, amounts to less than 1½ cents per tube at the rate timed, i.e., 20 seconds per tube, assuming the full capacity of the transformer; the average current used is very much lower. This fact and the cost for current used insures a liberal overhead for power, as it is understood that power is produced at less than 2 cents per kw.-hour at the switchboard.

The welding machine is made by the National Electric Welding Company, Warren, Ohio.

TESTING DEVICES FOR AIR BRAKES

At the recent Air Brake Association convention, Frank Sherman, air brake instructor of the Louisville & Nashville, spoke of a device that is used for testing air brakes in the repair yard or "rip" tracks. Ordinarily at these places the air pressure

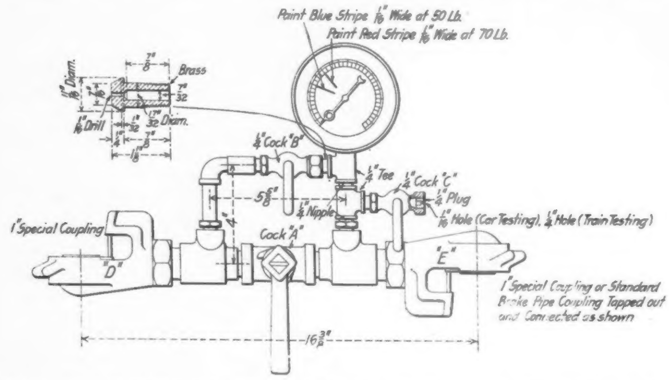


Fig. 1—Arrangement for Testing Air Brakes with Shop Line Pressure

is from 90 to 100 lb., and if pressure of this magnitude is used for testing, it may be found that cars that test out under it will not respond to the action of the engineer's brake valve under the ordinary train line pressure.

The device referred to is shown in the accompanying illustration, Fig. 1. The coupling *D* is connected to the air supply line and the coupling *E* to the car to be tested, the other end of the car, of course, being closed. Air is admitted to the train line under the car by opening the cock *A*. This will record the pressure on the gage shown, the cars to be charged to 70 lb. pressure and then the cock *A* closed. The brake pipe is then watched for leakage. The brakes are applied by opening the cock *C*, which allows the air to escape from the train line through a 1/16 in. opening as indicated. The pressure in the train line is reduced 20 lb., which should be sufficient to apply the brakes. The piston travel, which should not be less than 5 in. or more than 6 in., should also be noted. The brakes are released by opening the by-pass cock *B*, which is also provided with a 1/16 in. choke plug to provide a gradual rise of pressure in the train line similar to that received in service. The brake failing to release will indicate worn bushings or defecting packing rings in the triple valve piston. The device is of simple construction and is readily understood from the drawing. Where it is used for testing trains the discharge opening of cock *C* should be provided with ¼-in. choke, instead of 1/16 in.

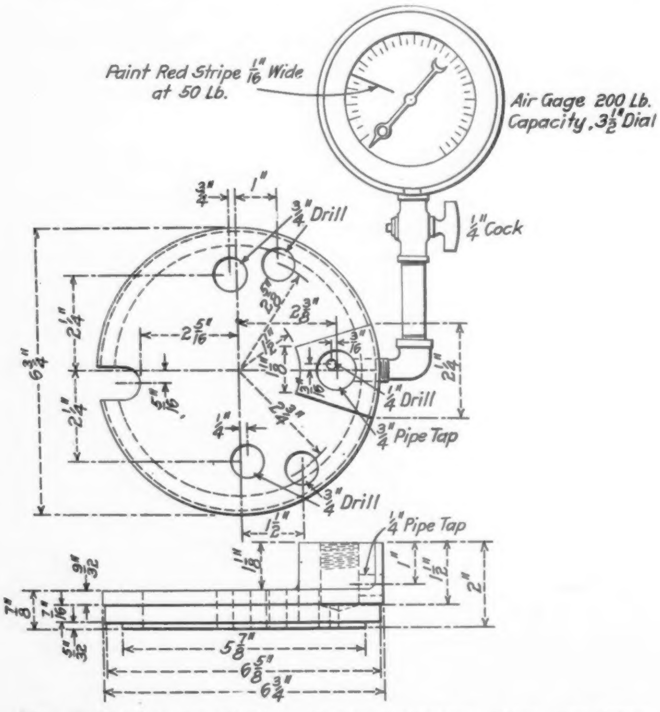


Fig. 2—Device for Testing Brake Cylinders After Repairing

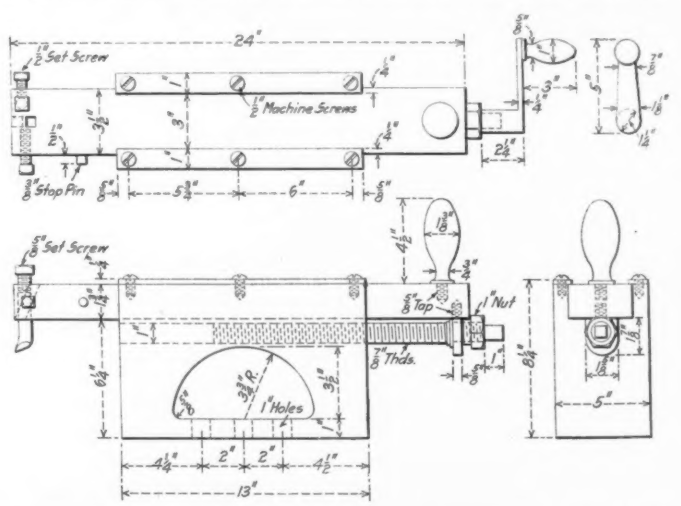
A device used for testing the leakage in brake cylinders that have been cleaned, oiled or repaired, is shown in Fig. 2. It is applied in place of the triple valve, the ¼-inch opening forming the connection between the brake cylinder and the gage shown in the illustration. The cylinder is charged to 50 lb. pressure, the supply cut off and the leakage noted. This leakage should not exceed 5 lb. per minute.

TURNING COMMUTATORS IN THE POWER HOUSE

BY H. L. LOUCKS
Machine Shop Foreman, Erie Railroad, Dunmore, Pa.

The device shown in the drawing is designed for use in turning and grooving commutators with the armatures in their own bearings. If this work is done in the machine shop it is necessary to remove the armature, thus disturbing what are probably good bearings, and often to work overtime in order to place the generator in service again with as little delay as possible. This procedure takes at least three or four days.

This device is designed to be attached to the journal box cap, which, as a rule, has a planed surface and requires the removal of one brush connection. When it is in place the engine is started and the armature turned with its own power.



Apparatus for Turning and Grooving Commutators with Armatures in Their Own Bearings

After this operation is completed the feed screw is removed and the handle applied to the tool slide, which is then used as a shaper to cut the mica between the commutator bars. A turning and a shaping operation are thus completed in about six hours and the generator is again in condition for service without serious delay.

Master Blacksmiths' Convention

Heat Treatment, Spring Making, Drop Forging, Electric Welding, Piece Work, Reclaiming Scrap, Etc.

The twenty-third annual convention of the International Railroad Master Blacksmiths' Association was held August 17-19 at the Walton Hotel, Philadelphia, Pa., T. F. Buckley, of the Delaware, Lackawanna & Western, president of the association, in the chair. The opening prayer was offered by Rev. Elmer M. Stapleton, and a short address was delivered by President Buckley. The association was welcomed to the city by Edward J. Cattel, city statistician, on behalf of the mayor. An address of welcome was also delivered by C. E. Carpenter, president of the E. F. Houghton Company, and C. E. Chambers, superintendent motive power, Central Railroad of New Jersey, spoke on the "Progress of Foremen Blacksmiths in Railroad Service."

ADDRESS BY C. E. CHAMBERS

Mr. Chambers spoke in part as follows:

No part of the railroad organization is more interesting to me than the blacksmith department; from the time I was a boy on an Illinois farm I have never ceased to be keenly interested in that work. No part of our great railroad organization has undergone more revision than the smith shop. True, many things are done nearly the same as in former years; flue welding still resembles the practice of many years back, excepting slight changes in scarfing and preparation. But spring making and repairing has been simplified and perfected by improved devices for assembling and banding, so that much of the manual labor has been reduced, and a better spring is produced. The oil, acetylene, electric and Thermit welding processes have entirely revamped some of our smith shop practices. Where once it was always necessary to remove an engine frame and take it to the smith shop for repairs, such a practice now would be almost an impossibility by reason of the extreme size and many complications of construction, which would not only greatly increase the cost of repairs, but would hold the locomotive out of service very much longer. Quite frequently we can make a weld and return to service the same, or next day, where our old system would require from 7 to 10 days, or possibly longer.

One of your subjects for consideration at this convention, that of heat treatment of metals, is deserving of careful study and consideration. Not only is heat treatment desirable for new material, but periodical annealing adds much to the life of many parts of locomotives and cars. No subject for your consideration should receive more careful attention than reclaiming of scrap. Everything must in time find its way to the scrap bin, but should not do so until it has served its last purpose. But there is a dividing line beyond which it is more economical to cast aside the old and use the new.

FLUE WELDING

E. J Haskins (New York Central)—We maintain four hundred modern engines at the Elkhart, Ind., shops. The tube welding and swedging is handled in the blacksmith shop. We have two flue rattlers, one 23 ft. long, and one 18 ft. long, running about 15 revolutions per minute with a load of about two hundred 2-in. flues. The 2-in, 2¼-in. and 3-in. tubes are cleaned in these rattlers in from two hours to four hours' time, the variation in time depending upon the amount of scale on them. After the tubes leave the rattler they are cut off at the firebox end with a belt driven cutter, having two rollers below with a rotary beveled cutter above. They are heated and the ends belled out on a horn and safe ends applied. One man swedges and welds tubes of 2-in., 2¼-in. and 3-in. diameter. After welding the tubes are brought to the hot saw, where they are heated in an oil furnace and sawed to proper length, the operator of this saw taking his own measurements for length from the boiler. They are then placed upright in a pit for the purpose of annealing the ends. About five men in the tube department handle from six to eight thousand flues per month of nine working hours a day.

After the flues are rattled we sometimes find them broken off at the first weld, where there are four or five welds. This is the most severe test the tubes are subjected to. We test all tubes that have more than one weld with a hydraulic testing machine at 300 lb. pressure, as we frequently find defects in the old welds. Our safe ends are made from new stock. We are able to weld successfully steel on steel, or steel on iron.

When bringing a tube up to welding heat great care must be exercised to heat uniformly, not too rapidly, and be sure not to overheat the steel safe end, thus making it brittle and resulting in failure in service, the fracture usually taking place through the steel portion near the weld.

The superheater flues of 5½-in. and 5⅜-in. diameter are cut off at the front flue sheet. After removal they are brought to the blacksmith shop to be cleaned and welded. We place about twenty of these flues in the rattler and mix with them one hundred tubes 2 in. in diameter. From two to four hours in the rattler cleans them very thoroughly. They are taken from the rattler and cut off at the firebox end. We do not scarf our safe ends on large superheater flues, but leave the safe end and flue full stock. We weld our superheater flues on the front end. The flues are then taken from the cutting-off machine to an oil furnace, heated and belled out with full thickness of material and safe end applied, then put back into the furnace, brought up to a welding heat and welded on the 200 lb. Bradley belt-driven hammer, for which we have constructed special mandrel and dies. We use three men for this operation, a flue welder and two helpers. We average about 11 flues per hour in welding and about 22 flues per hour in swedging on this machine. Superheater flues and 2 in. tubes are electric welded in the back tube sheet. We expect tubes so welded to last three years.

E. A. Wilkins (Pere Marquette) stated that flue welding at the Wyoming shops (Grand Rapids, Mich.) of the Pere Marquette was handled entirely in the boiler shop. As they are removed from the engine the tubes are placed on a special truck of convenient height. The truck is then pushed by three men to the flue rattler and stock shed. The arrangement for filling the rattler is such that two men can handle 250 or 300 tubes into it in 10 min. All the work on the tubes is done by three men, including rattling, cutting stub ends, heating and welding, cutting to length, testing and annealing, loading on the truck and returning it to the boiler shop. The output is at the rate of 60 to 75 tubes per hour of either 2-in., 2¼-in. or 3-in. diameter, either steel or iron. The arrangement of the flue furnace, welding machine and swedging block, together with the elevated welder's rollers, is such that the welding, heating, swedging and kicking the flue back into the receiving rack may be accomplished by the operator without moving out of a four-foot circle. From the time the tube leaves the rattler it is never handled twice in the same operation, and the entire job is completed at a cost of 3.69 cents per tube. Superheater flues 5⅜ in. and 5½ in. in diameter are handled in the same manner, but at an increased cost, owing to the fact that but from 15 to 20 of these flues can be handled per hour. All tubes are applied to the boiler at a cost of 6.535 cents each, making a total cost of tubes out and into the boiler, in 100 lots, of 10.225 cents per tube, or $10.225 per hundred.

MAKING AND REPAIRING FROGS AND CROSSINGS

F. A. Watts (Delaware, Lackawanna & Western) described the method employed in the frog and switch shop at Dover, N.

J., where a large amount of new work is handled. The shop is divided into three departments; a blacksmith shop, where all forgings, plate work, rod work and switch stand shafts are repaired; the planing and drilling room, and the erecting floor, where work is assembled, bolted up, riveted and finished ready for shipment. All rail drilling is done on a four-spindle multiple drill and planers of the heaviest type are in use.

The monthly output of this plant was given as follows:

150-175 switch points.
150-175 pairs frogs complete.
8-10 crossings of various angles.
6-8 slip switches.
100-150 switch stands.
500 pairs of compromise angle bars (approximately).

Rails are received by the carload and enter the shop near the rail bed, where they are unloaded. They are then handled to the saws by two operators, who saw them to length and deliver them to the drilling machine. They are then passed to a bench, where the reinforcing bars are riveted on, after which they go to a planer and then to a second planer for the last operation. They are then passed to the bender or straightening machine and thence to the riveting bench, where the lugs are riveted on. A pair of points has not traveled over 50 ft. from the saws in any direction during these operations. The labor cost on a 16-ft. 6-in. switch of 101 lb. rail is approximately $4.

In making frogs the points and side rails are passed from the saws in one direction to the bending machine, where they are bent to template, next to the drilling machine, where they are drilled for riveting together, and thence to the planer room, where operations are performed on three planers. The point and side rails are riveted together near the last planer, and then pass to the erecting room. The wing rails when sawed go in the opposite direction, passing directly to the erecting room, where the bender and drill presses used on them are located. The handling of material is facilitated by the use of tramway tracks and air hoists, and the arrangement of the plant is such that when finished the frogs are piled not over 125 ft. from the rail pile whence came the new material.

The cost of cutting up old frogs, handling the scrap material to and from the hammer, and placing it in piles ready for shipment never exceeds 20 cents per frog. This low cost is due to the use of a special rivet buster of local design. In cutting up old frogs all frog plates, reinforcing bars, tie plates, spikes, bolts, nuts and other material fit for future use, or which can be reclaimed, is saved, with a net saving to the company of $25,000 per year more than would be received if the material were sold for scrap.

CARBON AND HIGH-SPEED STEEL

H. W. Loughridge (Pittsburgh & Lake Erie): Nearly every mechanical magazine, each month, has an article of some kind on steel and its uses. The steel makers furnish working directions for each kind of steel that is made by them. It would therefore seem that with so much information and data at hand it would be impossible to go wrong, were it not for the fact that fully two-thirds of the articles written are not read by the men who do the work. The articles are all good and written by men who thoroughly understand what they are writing about, but their enthusiasm carries them away, with the result that the man on the job or at the forge is lost in a dense fog.

In considering the forging, annealing, hardening and tempering of the various grades of straight carbon steel, we are confronted with a much more difficult proposition than when considering high-speed steel, from the fact that most carbon steel has a very limited range of treatment, being more sensitive and easily ruined in forging and hardening. Therefore greater care must be taken in selecting the kind of steel most suited to the kind of work it is to be used for and on ascertaining and following the correct method of forging and hardening to produce the best results.

We have heard considerable about the critical temperature of steel, the fact being emphasized that this is the proper heat to harden, but we do not hear anything about the forging operation, which has just as much to do with the life of the steel as the hardening process. In fact, no amount of heat treatment will be of any use if the forging has not been properly done. This also applies to the annealing process, which must be properly done. A simple way to overcome this trouble would be to put it up to the company from which your steel is purchased. Let them give the carbon content, the forging temperature, the hardening temperature, the annealing temperature. After receiving this information and following the instructions, if the steel should be a failure it will be up to manufacturer. High-speed and carbon alloy steel seem to be coming into quite general use, and as both of these require higher temperatures for forging and hardening, carbon steel must and does suffer. As it was a hard proposition to get men to heat to a high heat when high-speed steel was first introduced, it is now equally hard to get them to heat carbon steel at a low heat. The majority of failures in carbon steel can be traced to too high heat either in the operation of forging, annealing or hardening. Keep the heat down, never forge below the critical point, never anneal below the critical point, always harden at the lowest heat at which the steel will harden, and be sure that the forging, annealing and hardening heats are uniform. By a uniform heat I do not mean that you should let the heat go away up to 1,600 or 1,700 deg. F. and then cool back to 1,450 or 1,500 deg. F., and attempt to harden then.

As an example, heat a piece of steel to 1550 deg. F., let it cool back to 1,450 or 1,475 deg. F. and quench. Break the end and you will find the steel will show the effect of 1,550 deg. F. High-speed steel must be heated to a much higher temperature for forging and tempering than carbon steel. A temperature of 1,400 deg. F. to 1,600 deg. F. is sufficient for most carbon steels. High-speed steel requires from 1,800 deg. F. to 2,300 deg. F. It is best at all times to follow the instructions of the makers. High-speed steel should never be forged below a bright yellow heat. If unable to finish the job in one heat put it back into the fire and finish in a second or third heat if necessary. Heavy lathe tools should be put into the fire after forging and warmed up to 1,450 or 1,500 deg. F. and allowed to cool. This will relieve any strain that may have been set up in the forging operation.

Tempering of Taps and Dies.—The methods used at the P. & L. E. shops at McKees Rocks, Pa., are as follows: Two muffle furnaces are in constant use; one is kept at 1,400 to 1,450 deg. F., and the other between 2,000 and 2,200 deg. F. All carbon steel taps and dies hardened in the low temperature furnace, the heat always depending upon the critical point of the steel being used. Then cool in clean water at about 60 deg. F. They are then drawn in oil at 450 or 500 deg. F. The larger tools are treated in the same manner, only they are held in the water until the vibration ceases, then put into cold oil until cold and drawn immediately to the desired temperature in oil. High-speed steel is first preheated in the low temperature furnace to about 1,450 deg. F., then put into the high temperature furnace and held at about 1,900 to 2,000 deg. F., then quenched in the oil and drawn to 500 or 600 deg. F., the temper depending on the tool.

DISCUSSION

The importance of care in heating steels was brought out in the discussion and there was a pronounced expression among the members in favor of the use of modern appliances in the heat treatment of steel, especially in the manufacture of taps and dies and reamers. Where the open fire must be used the importance of regulating the temperature of the fire to agree with the temperature desired in the steel was brought out, as it is impossible to take a red heat out of a white fire. To insure against warping of reamers and taps the importance of providing a perfectly straight forging before finishing in the lathe was emphasized, good results having been consistently obtained where this practice is followed. The use of carbon steel is being considerably reduced by the introduction of alloy steels. It is the

general opinion that many of the failures in forging and heat treating steels which are attributed to the blacksmith are due to a lack of knowledge on his part as to the quality of the steel and therefore as to the proper methods of heating for forging and hardening in the shop.

PIECE WORK

P. T. Lavender (Norfolk & Western): When we have a piece of work which is standard and will be ordered in sufficient quantities to justify setting a price, we first make our necessary dies and formers for either the drop hammer, forging machine or bulldozer. The dies are then tried to see that the work done is in accordance with blue print and the workman and foreman then agree on the price to be paid. I have found that by following this rule of handling piece work there is no difficulty in getting along with the men. We are told that the piece work system causes men to do their work hastily and carelessly. We can easily see that this is not true, for in such cases as unsatisfactory work is done it is turned back to the man to be done over on his own time. Piece work brings out the best in a man and it teaches him how to handle himself and to think ahead. It makes a man self-reliant.

A. W. Ackley (Delaware, Lackawanna & Western): Some foremen have the idea that piece work is simply a way of increasing wages and forget that by altering the price on this or that job they are simply destroying the object of piece work and making trouble for themselves. Prices cannot be changed to favor one man and not another without causing friction among the men. When the foreman changes the method of doing a certain piece of work the price should be adjusted at once. I have known cases where changes have been made and the price left unchanged in which the foreman eventually had to resign simply because he had not taken advantage of the tools he had created.

Some foremen leave the making and repairing of parts to the judgment of the blacksmith doing the work. Naturally this man is going to take the easiest and best paying method for himself. You may have all kinds of prices for straightening certain classes of work and allow the highest price all the time. Spring hangers may be sent from the erecting shop for annealing and the blacksmith will touch up the end and, of course, close the holes when they are not worn enough to warrant such additional work. The blacksmith foreman should see personally all work coming to the shop and be in a position to say just what should be done in all cases. When setting piece work prices the foreman should see that the method of doing the work is according to his instructions, as in numerous cases work can be made to take much more time when setting a price than after the price has been set.

J. H. Daltry (Erie): We work about 60 per cent piece work at our Buffalo, N. Y., shops, both on repair and new work, and I consider it the best way of doing work. After a man works on piece work he does not want to return to day work. It is claimed that as good work is not secured under the piece work system as by the day, but I do not think that is true. We very seldom have a job to be done over. If a man is required to do a poor job over again on his own time he will be more careful afterwards to do his work right the first time.

RECLAIMING SCRAP

Thomas M. Ross (Buffalo, Rochester & Pittsburgh): The scrap pile, when properly handled, is one of the most economical and important features in connection with railroad service. In many instances material can be found in the scrap pile which answers the purpose as well as new material. For instance, old rake handles, brake levers, brake rods, jaws, brake hangers, etc., can often be used again to advantage. Old arch bars, draw head pockets, truss rods, etc., are re-rolled into different sizes of round iron, which is then used in the manufacture of bolts, grab irons, engine rakes, and used for general repair work. The arch bars are sheared into small pieces, and the draw head pockets are cut into pieces by acetylene gas. These pieces are then heated in the furnace and split by rolling machine, and then rolled into the different sizes of round iron required. These methods are only adopted when rolling smaller than one inch round iron. When rolling one inch round iron, and over, whole arch bars are used. Steel crank pins are used in numerous cases for making wrenches and small forgings. Coil springs are extensively used in the manufacture of car repairer's drift pins, and pinch bars. Tire steel is principally used for making car repairer's hammers, and coal picks. It is not suitable for tools that must withstand blows from sledges, owing to its tendency to break off in chunks. Machine tools which become too short or otherwise defective are drawn out and made into smaller tools.

J. Tootell (Chicago & North Western): The North Western began to sort out scrap about 20 years ago, each year doing a little more. Some five or six years ago we went into the proposition more extensively and reclaimed everything of usable value. Two shops were built of lumber from old cars, one 24 ft. by 180 ft., and the other 40 ft. by 180 ft. These shops contain the following equipment:

5 Bradley hammers for straightening old bolts.
4 nut strippers to strip nuts from bolts and rods.
3 double and one single shears for cutting old bolts to length and also for cutting up scrap and rods for the rolling mills.
1 steam hammer for removing pockets from old couplers, straightening deadwood plates, draft stems, brake levers, etc.
1 upright power hammer for straightening rods.
2 rolling mills to roll from ¾ in. to 2 in. round iron.
5 oil furnaces: One for the steam hammers, two double furnaces for the rolling mills, one for springs, and the other for straightening miscellaneous material.
1 small bulldozer for bending pin lifters, brake hangers, etc.
1 drill press and emery wheel for repairing old monkey wrenches, shovels, etc.
1 machine for making new grab irons.
5 forges for straightening connecting rods, grab irons, and switch rods.

We have a spring plant for resetting and tempering coil springs and a tester for testing them before they are put in service. We also repair all switch stands in these shops, all air cylinders, valves, steam and air hose, straighten track spikes and sort out nuts and washers. From 20 to 25 cars of scrap are unloaded per day; about five old cars are burned and seven broken up per day. All scrap is sorted as it is unloaded, and distributed to the various shops where repairs are to be made.

The following statement will give an idea of some of the work turned out in the reclaiming plant in one month: Rerolling iron, ¾ in., ⅞ in. and 1 in. round, 361,791 lb.; straightening and cutting to length old bolts and rode, 257,950 lb.; 3,158 draw bar and truck coil springs reset and tempered. These items cover only the material reclaimed from condemned cars.

C. L. Gay (Atlantic Coast Line): We have been reclaiming all of the round iron used from ½ in. to 1 in. in diameter. This is done on an Ajax rolling machine. Manufactured material which has been used and thrown into the scrap pile bent up in various shapes is sorted out and hauled to a two-door Ferguson oil furnace about 8 ft. long. Two men, one at each door, fill up the furnace; after the material is heated it is taken to a straightening slab and brought back to shape. When cool it is removed to a platform nearby, from which it is used as needed. The following is a summary of the operation of the reclaiming rolls at the South Rocky Mount, N. C., shops for the month of December, 1914:

The amount of round iron from ½ in. to 1 in. in diameter reclaimed for the month was 51,803 lb., the saving account of reclaiming (difference between price of new iron and scrap value) being $336.72.

COST OF RECLAIMING.

30,000 lb. at contract price of $2.50 per ton	$37.50
21,803 lb. at day rates (includes the time of one head roller, one assistant head roller, one head feeder and two assistant feeders for 39 hours each)	72.82
Total cost of fuel, electricity, overhead charge and repairs	148.92
Total cost of reclaiming	$221.74

Deducting $221.74 from $336.72 leaves a net saving of $114.98

for the 11 days of operation during the month of December, 1914.

SPRING MAKING AND REPAIRING

Thomas E. Williams (Chicago & North Western): In so far as possible, all the spring work for a system should be concentrated at the main shop of the company. Small outlying plants do not pay, for spring work should under no condition be attempted without proper machinery and, as a rule, it is not advisable to install such machinery at outlying points on account of the small amount of work to be done. Once there becomes work enough to allow of the installation and operation of the proper spring making machinery, further expansion is very easily taken care of, because the same number of machines are necessary for a relatively large amount of work as for a small amount. While the quantity of work is still small a workman may operate more than one machine. For instance, at the Chicago shops of the North Western, four machines are required to prepare the steel for use. At present, one man and two helpers operate all four machines. Should the amount of work increase all that would be necessary would be to hire more operators. The tempering furnace is most influenced by quantity of work. Provision must be made for more doors in case of an increase of work. Practically the same equipment is suitable for both new and repair work.

For the manufacture of new springs the material is received in bars from 12 ft. to 18 ft. in length. The first operation is to cut the bars into proper lengths. All pieces of the same length are cut at the same time. The next operation is that of punching the leaves requiring it and the third operation is that of centering all plates on a nibbing machine. The next operation is rolling out the ends of the leaves, which are now ready for fitting and tempering. A standard form is kept for the first leaf of every standard spring and, when this first leaf has been rolled and hardened, all the remaining leaves are easily made by rolling to the preceding leaf. The rolling and tempering are done at the same heat, about 1,650 deg. F. As soon as the leaf is shaped, it is plunged in an oil bath and allowed to cool, after which it is placed in the furnace and allowed to remain there until the oil flashes. The leaves are then piled in their proper order and are ready for banding. This is done by first gripping them in a hydraulic clamp and slipping on a temporary band which holds them until the permanent one is applied. For the application of the permanent band a hydraulic press is used. The band is first heated to about 1,850 deg. F., slipped over the spring and then squeezed in the press and held until cool. The spring is now ready for service except for painting. Occasionally springs are tested to see that the proper standards are being maintained. Repair work is handled practically the same way as new work. All spring bands used are machine made. After the material has been sheared off to the proper length, it is bent into a U shape on a bulldozer, and the weld made in a forging machine. No broken bands are repaired, as the machine made bands are so cheap that a band once broken is scrapped.

For shaping material five machines are used: A combination shearing and punching machine; a roll served by a furnace, for tapering leaf ends; a nibbing machine for putting the centers in the leaves; a trimming machine, and a gibbing machine. The fitting and tempering apparatus includes a furnace for heating and tempering face plates, tanks for oil baths and hand rolls for rolling the leaves to shape. The finishing machinery includes a hydraulic clamp, a hydraulic banding press served by a furnace for heating bands, and a testing machine for trying the springs. For the operation of this equipment fifteen men are regularly employed

C. V. Landrum (Nashville, Chattanooga & St. Louis): I found that on springs rolled with the convex roller on the bottom the plate was cupped so that when loaded the strain was on the edge of the plate, making it much easier to break. I reversed the conditions, which had the effect of putting the tension on the center of the plate, and compressed the edges. The result proved satisfactory, as it reduced the number of failures from that cause. The plates are rolled and cooled off at the same heat, then another hot plate is rolled on it, which is all the drawing the spring sets. The most of our failures have from one to three top plates broken, and in nineteen times out of twenty the balance of the spring retains its correct set, requiring very little work to put it back into service. We use crude oil for tempering purposes, with air from the shop blast to keep it cool. We have a shop-made machine which we call a spring machine. It will nib, roll, trim, slot and crimp the main plate for the gib, all in one machine worked by air. We also have an attachment that centers the plate lengthwise and sidewise, leaving no measuring or center punching to be done.

If we could get the same grade of steel all the time, the spring failures would be reduced to a very great extent. Different grades of steel mixed together, calling for different treatment which can not be given, for the simple reason that the smith cannot tell one grade from the other, will forever cause spring troubles, and the sooner the railroads realize this fact the sooner they will save the money that now goes to the spring steel scrap heap.

Geo. P. White (Missouri, Kansas & Texas): All of our springs are repaired on a store department shop order, thereby keeping a stock of springs on hand, and not returning to the engine direct. By this system we repair our springs in lots of not less than six of each class. We have a template for our main plates, fitting all six main plates to the template. Our first plates fitted are cool enough to proceed with the second plates by the time

Fig. 1—Locomotive Spring Hanger

the sixth plate is fitted. This way there is no loss of time waiting for plates to cool in the oil, and flashing the temper. After the entire springs have been fitted up they are turned over to a helper to flash the temper. This is done in muffled chamber at a much lower temperature than in the fitting furnace, thereby eliminating a large number of broken plates caused by edges of the steel spring being drawn and the center remaining hard; also spring not carrying the load on account of temper being drawn

too far. Our bands are bent on a bulldozer and welded up on a forging machine at a very low cost compared with the old methods. They are pressed on with a hydraulic machine such as is used in nearly all large repair shops.

Each spring has the class number and date repaired stamped on the band.

DISCUSSION

Attention was called to the need of proper appliances in the manufacture of springs, especially in the heating and drawing of the plates. The question of tapering the ends of the leaves brought forth considerable discussion. This practice has been abandoned by the Pennsylvania and the Lehigh Valley, the leaves being sheared and hardened without finish on the ends, with

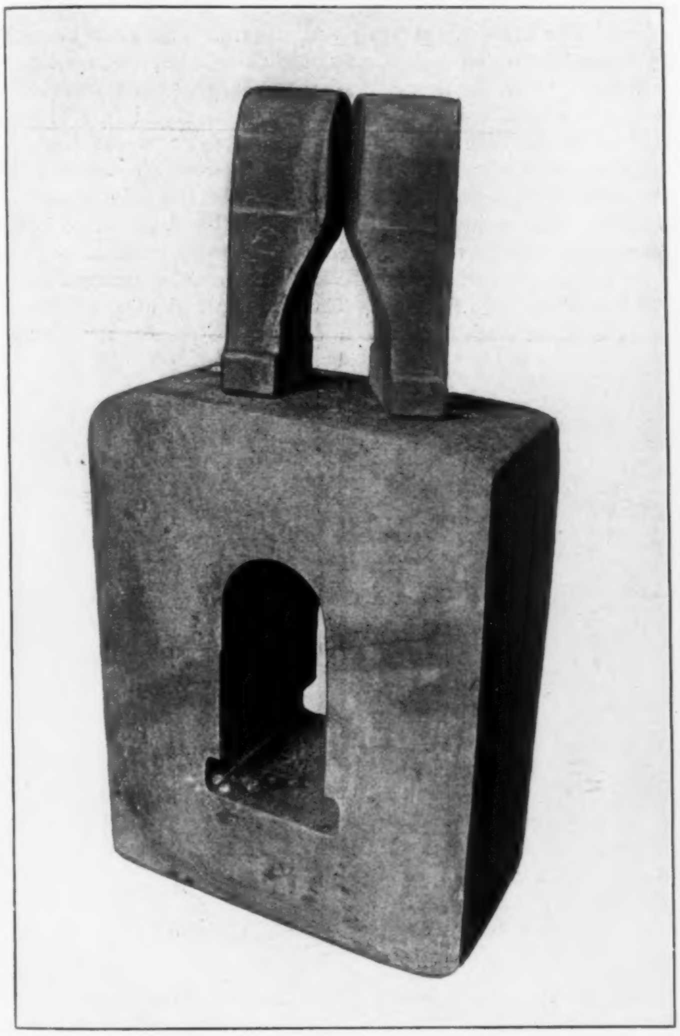


Fig. 2—Cup and Blocks for Forming Spring Hanger Shown in Fig. 1

apparently satisfactory results. Several of the members, however, objected to this practice on the ground that it tends to destroy the uniformity of the flexibility of the springs. The use of machine-made spring bands is quite general. They are applied with a banding press and allowed to cool while clamped in the press, thus preventing the tension of the spring from stretching the hot band. The fact was emphasized that one-fourth of trouble with plate springs is the varying quality of steel, the variations being unknown to the blacksmith, who is thus unable to handle the material properly.

J. W. Russell (Pennsylvania Railroad) stated that where pyrometers are used they should be checked by means of a test pyrometer kept for that purpose. The test pyrometer should be checked occasionally by means of a salt bath, the melting point of salt being very near to the high point used in heat treating spring steel; that is, about 1,472 deg. F. Two plates from each day's production should be subjected to a transverse deflection test. Mr. Russell submitted the accompanying table showing the deflections for various spans and thicknesses of material, which indicate that the material has an elastic limit of not less than 120,000 lb. per sq. in., providing the material does not receive a permanent set to exceed .01 in. After the deflection test the plates should be broken and the angle at which failure occurs observed. This angle should not be less than shown in the table; the greater the angle the better is the heat treatment.

DEFLECTION AND BREAKING TEST OF SPRING PLATES.

Thickness of Steel, Inches.	Tranverse Span in Inches.	Deflection Test. Deflection in Hundredths of an Inch.	Breaking Test. Minimum Angle of Breakage, Degrees.
¼	18	104	63
9/32	18	93	55
5/16	18	83	50
11/32	18	76	46
⅜	18	69	42
13/32	18	55	39
7/16	24	114	36
15/32	24	99	33
½	24	93	31
17/32	24	87	29
9/16	24	82	28
19/32	24	78	26
⅝	24	74	25

CASE HARDENING

C. V. Landrum (Nashville, Chattanooga & St. Louis): I use the old method of casehardening—bone meal, old leather, pulverized charcoal and a little sprinkling of prussiate of potash. I use a drum 12 in. in diameter and from two to four feet long, the length being governed by the amount to be hardened. I turn a slight flange on one end of the drum, stand it on end, cut

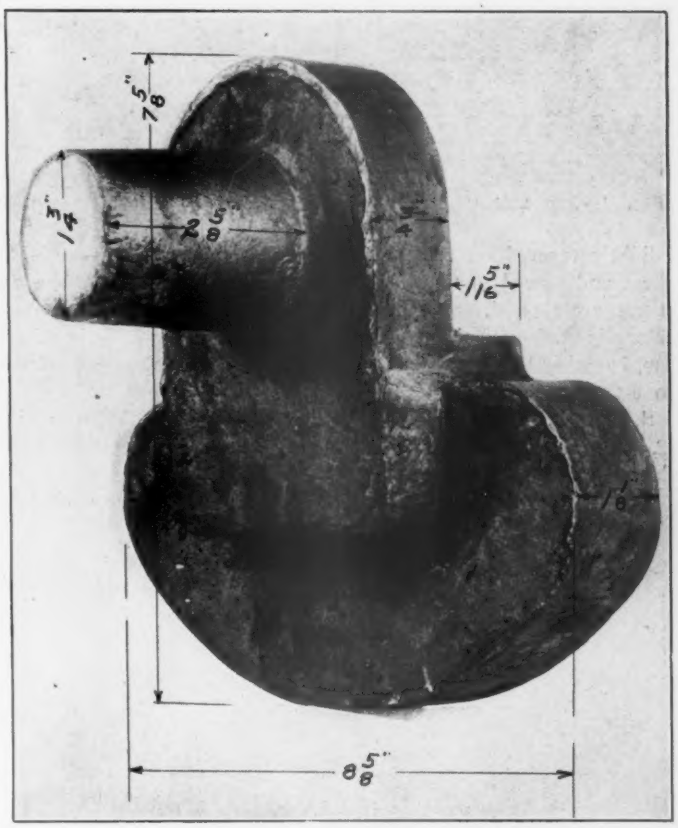


Fig. 3—Link Trunion

out a piece of ¼ in. or ⅜ in. iron to fit, then drop it in and put about two inches of fire clay on top of it, pack it well so as to make it as near air tight as possible, then put in about 2 in. or 3 in. of bone meal and old leather, cut up; then a layer of pieces to be hardened is packed in. Space is left at the top for two or three inches of fire clay, which is held in place by another ¼ in. or ⅜ in. iron plate, a ⅝ in. bolt passing through holes in the drum to keep it in place. It is then placed in the furnace and kept 1,600 or 1,700 deg. F., as near as I can come to it without a pyrometer.

That temperature maintained for eight hours will penetrate ⅛ in. deep. If the heat is lower the case will be thinner. For quick work or a roundhouse job I use ¾ lb. of prussiate of potash to 1 gal. of pulverized charcoal. This put in a pipe just large enough to accommodate the pieces to be hardened and kept at the highest practicable temperature one and a half hours will penetrate 1/16 in., making a good hard case. Both ends of the pipe must be closed with fire clay.

DROP FORGING

J. W. McDonald (Pennsylvania Railroad): We do not have a drop forge hammer at our shops. However, we are following out work along the same line by using cup blocks, from which we get very good results, although we have a flash to trim by hand.

Fig. 1 outlines a spring hanger support for one of our heavy locomotives used in passenger service. This piece is made from hammered iron and is first roughed down to 4 in. by 5 in. by 6 in. slightly tapered on one end. It is then reheated to a welding heat and placed in the die between the top and bottom blocks; these are then driven together by steam hammer until the top block is flush with the top of the die. After the cup die is raised up, by using blocks underneath it and by using a plunger to drive out the work and forms, there is no further labor to be done other than to trim the flash. The die and block are shown in Fig 2. We have just recently completed 400 of these pieces at a very low cost, although the cost is somewhat higher than the same work done in drop-forge dies. There is a very large saving in labor cost as compared to forging and finishing at the anvil. In making this piece we start with 34 lb. of material; after the flash is removed the finished piece weighs 32½ lb. It is necessary in forming work in cup dies to have just about the right weight, otherwise the strain on the tools is very severe, due to surplus stock finding its way between the cup and plunger. The cup block is made of billet steel; the top and bottom forms are made of tool steel.

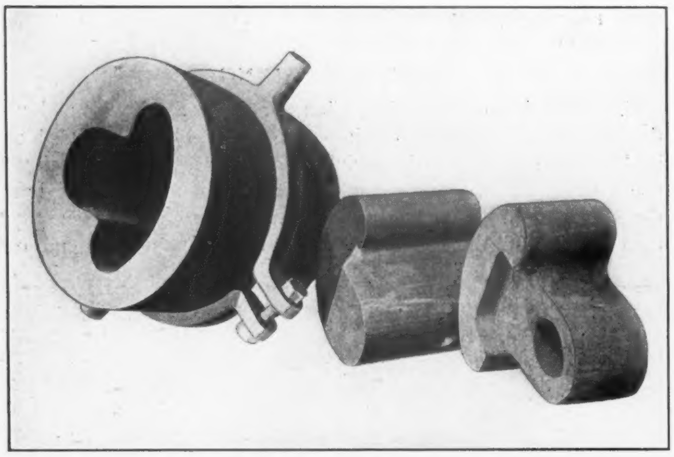


Fig. 4—Cup and Blocks for Forming Link Trunnion Shown in Fig. 3

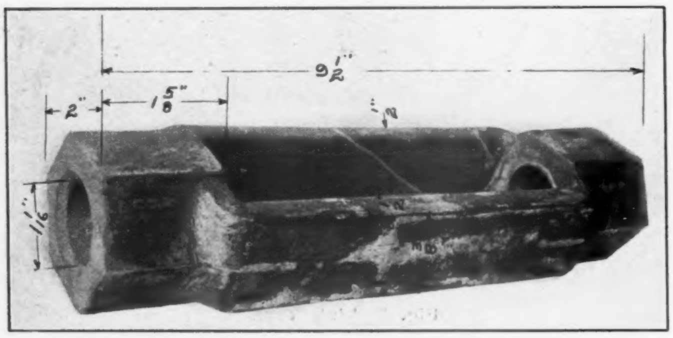


Fig. 5—Turnbuckle Formed in Dies Shown in Fig. 6

Fig. 3 shows a link trunnion and Fig. 4 the cup and blocks for forming it. We first forge this piece from hammered iron, and bend the stem at right angles to the body, which is forged square. This will assure that the fibres of the metal will flow in the direction intended, assuring a solid stem. The iron is then re-heated to a welding heat, then placed in the die between top and bottom blocks and the top block driven down flush with the top of the die under the steam hammer. After the flash is trimmed we have the finished piece as shown in Fig. 3.

We form the top and bottom ends of smoke-box frame braces in dies used on our 5,000-lb. steam hammer, impressions being cut out in the dies to properly form the pads on the ends.

Fig. 5 is a 1¼-in. turnbuckle, the dies for making which are shown in Fig. 6. The iron is offset 3 in. from each end, 11/16 in. deep. Then two pieces are placed together and after taking a welding heat on one end are placed in the bottom impression of the die. After the first operation we have the hex formed on one end with a hole about 1¼ in. deep. A round face plunger is used in this operation. This answers two purposes: first, one need not use any filling-in piece; and, second, it sets out the corners by plunging the hot metal against the solid center of the die. It is again re-heated to a welding heat and placed in the top impression in the die, where the plunger punches out the slug and at the same time stencils the shop and company's mark. This completes the first end. The same operations are followed on the other end, after which the work is ready for tapping the thread. While there is a small flash this is removed by placing about 300 pieces in the flue rattler and rattled about two hours, not using any water. This removes the flash and polishes the work at the same time. This turnbuckle is made at a very small labor cost. The dies are made of scrap axle steel with a tool steel insert in the center of the die for punching the hole.

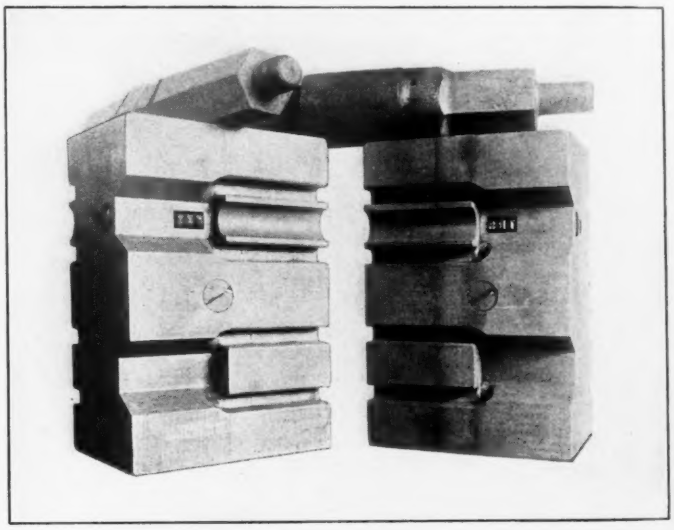


Fig. 6—Dies for Forming Turnbuckles

DISCUSSION

H. E. Gamble (Pennsylvania Railroad): We are running our drop hammers night and day. The largest dies we have in use measure 12 in. by 30 in. by 36 in. and weigh 3,560 lb. each. They are of Vanadium cast steel. We have not as yet been successful in eliminating the breaking of hammer rods and dies, heat cracks appearing in the latter from continuous use.

ELECTRIC WELDING

Joseph Grine (New York Central): It is our opinion that electric welders in locomotive shops should all be placed under the blacksmith foreman for the following reasons: (a) His knowledge of the properties of, and the effects of heat on iron and steel places him in a position to handle this work very successfully. (b) His access to all classes of work in all departments places him in a position to get up new methods of doing

the work and to advantageously balance up the work in all departments. (c) Because of the specialized nature of this work it can be handled better by one man with access to all departments than by each department head. Standardization of practice is more readily attained. The blacksmith foremen have taken the wrong attitude and tried to avoid or shirk this responsibility.

At the shop on the railroad with which I am connected, we

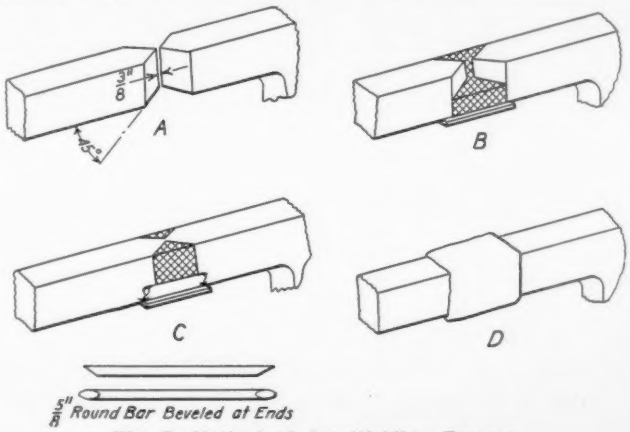


Fig. 7—Method of Arc-Welding Frames

are using the electric-welding machines on a large number of different operations, some of which, with the saving effected, are given below:

No. of Units	Description of Work	Approx. Saving Effected
265	Broken frames welded	$15,000.00
60	Cracked cylinders welded	14,000.00
28	Front deck castings welded	1,360.00
325	Fireboxes welded	890.00
137	Sets of flues welded in back flue sheet	*1,000.00
76	Sharp flanges filled in tires	650.00
78	Flat spots filled in tires	700.00
40	Mud rings welded or reinforced	400.00

*Per year in maintenance of these flues.

It is conservatively estimated that the annual saving at this one shop is approximately $30,000. All savings noted above are net savings above cost of labor, material and electric current to perform the operations.

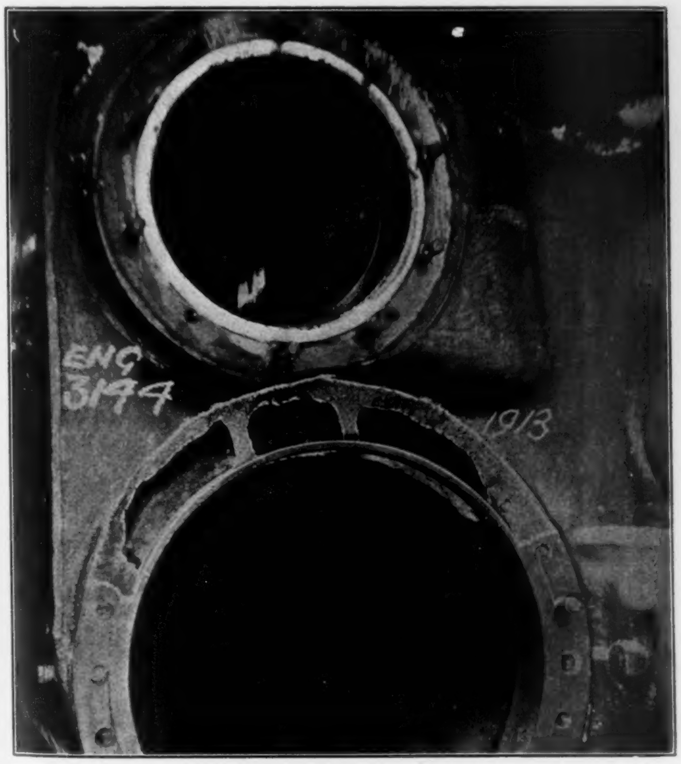


Fig. 8—Broken Cylinder Repaired by Arc Welding

Experience has shown us that in almost every class of work satisfactory results can be obtained without the use of flux, providing the parts to be welded are clean.

The frame at crack is first V'd out on both sides with the oxy-acetylene cutting flame, and chipped out with an air hammer and chisel to get a clean surface as shown at A in Fig. 7. A ⅝-in. plate, about 1 in. wider than the frame, is then fastened to the bottom. From this as a basis the electric welder builds up the full width of the frame first on one side and then on the other as shown at B. After the V is filled on both sides, ⅝-in. round bars about 2 in. longer than the full width of the V are welded on the outside as reinforcement, starting at the bottom and building up (see C, Fig. 7). The very fact that these bars are round enables the operator to easily and successfully weld them in by being able to get in around them. The completed weld is shown at D.

A great number of shops use the electric-welding process very successfully in fireboxes, welding cracks, applying patches, applying new side sheets and ¾-door sheets, filling up corroded or worn places in all sheets, welding mud rings, welding in tubes in back-tube sheet, welding cracks in bridges and checks in flanges of sheets. In welding in tubes, the tubes should be applied the same as if no welding was to be done. After they are applied the sheets should be cleaned and roughed before welding. Care should be taken that the voltage is not too high. A voltage of 64 with 125 amperes gives good results. Welding tubes is most economical in good water sections where two or three years may be expected between renewals, but it pays to weld them if only one year is expected of them, as it saves engine-house troubles.

Fig. 9—Cylinder Prepared for Welding

An engine came to the shops with left cylinder broken over the three steam ports, a space about 36 in., with the cylinder bushing still intact, as shown in Fig. 8. The cylinder was drilled and tapped for ½-in. studs, in order to provide, through the steel or iron studs, something suitable on which to anchor the electric welding. Fig. 9 shows the studs applied and a quarter circle of 2¼ in. by 2½ in. soft steel faced off and bored to fit the radius of the cylinder placed on top of bushing The back part of this piece was beveled off to form a scarf. The electric welding starts at the top, gradually working the metal down into the

circle, care being taken to avoid closing the steam ports. This engine has been in service since October 1, 1913, and up to date has given no trouble from this weld. Welding a crack the full length of cylinder with this method is a very simple job. The crack is first cut in V shape at an angle of 45 deg. and a row of ½-in. studs placed on each side of the V about 1 in. or 1¼ in. apart. It is not necessary to let studs project over the cast iron more than ¼ in.

Manufacturers sometimes do not give the operators a chance to master the process before they make up their minds that the method is not feasible. It does not require as skillful handling to make a good arc weld as it does to make a good weld on an anvil.

In order to show the relative strength of electric welds compared with the original material welded, a test was made of four pieces of ⅜-in. firebox steel welded by the electrode process. These were placed in a testing machine and the breaking strain found. One piece broke in the original steel and the other three pieces broke through the weld. The results are given in the table:

Breaking strain per inch width.	Per cent strength of material.	Remarks.
21,700 lb.	99	Broke through weld
19,900 lb.	91	Broke through weld
21,840 lb.	100	Broke in steel
18,090 lb.	82	Broke through weld

All four test pieces were reinforced according to our standard practice.

C. A. Slenker (Long Island Railroad): We did not accomplish much with our machine outside of boiler work and not a great deal of that. As to heavy welding, such as locomotive frames and mud-ring corners, we have not done any of that kind of work yet. Where a forging is removed from an engine, such as spring hangers and brake rigging, we cannot do it cheaper with electricity than in the smith shop. I have tried it out carefully and compared it with my piecework prices and I find that the smith shop is cheaper on piecework basis. We have welded a number of experimental pieces and upon breaking them we find the material at fracture is laminated with layers of slag and scale throughout the entire weld and we also find it

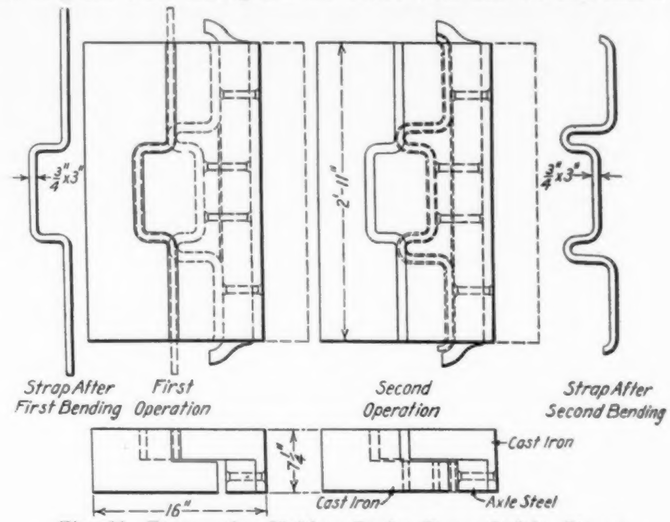


Fig. 11—Former for Making Brake Beam Safety Straps

crystallized. If we could keep the slag from forming, I believe we could do a fairly good job.

There is a company in Newark, N. J., called the Quasi-arc Weltrode Company. The only point in which their scheme differs from the ordinary pencil arc-welding is in their "weltrode," which consists of a metallic rod covered with slag. It is not necessary for the operator carefully to hold his arc; the slag on the end of the weltrode rests on the work when the arc is drawn between the end of the wire and the work. As the wire melts away, the slag also melts, the claim being that the air is entirely excluded from the molten metal. As each layer of metal is applied the slag forming on top is broken away with

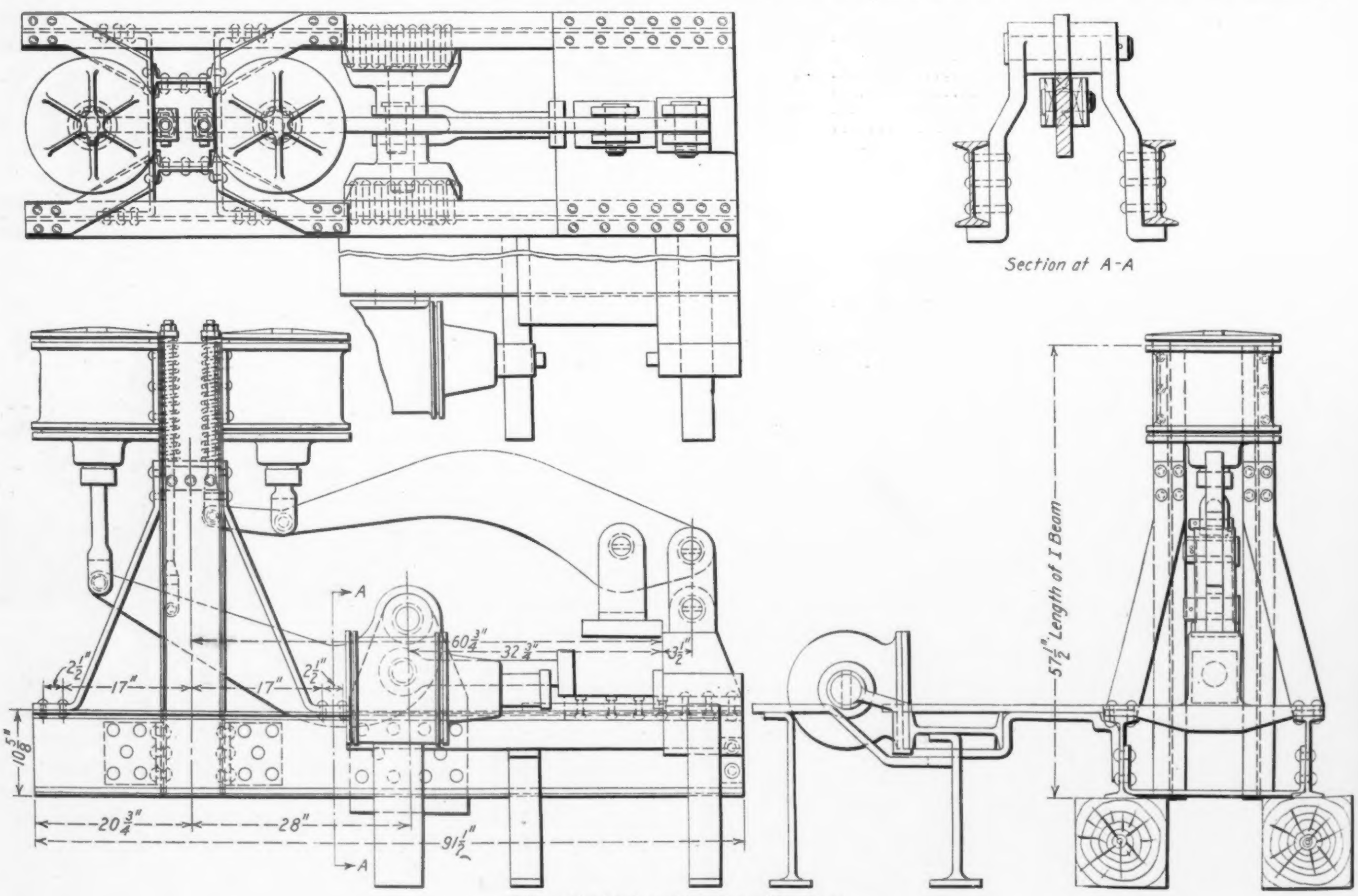


Fig. 10—Spring Banding Machine

a scaling hammer. A wire brush is used thoroughly to clean the top of new metal that has been added and then the next layer is applied.

P. T. Lavender (Norfolk & Western) said that the electric welding at the Roanoke shops is under charge of the erecting and boiler shop foreman. The method employed is the metalic electrode method. The arc is drawn by touching the work

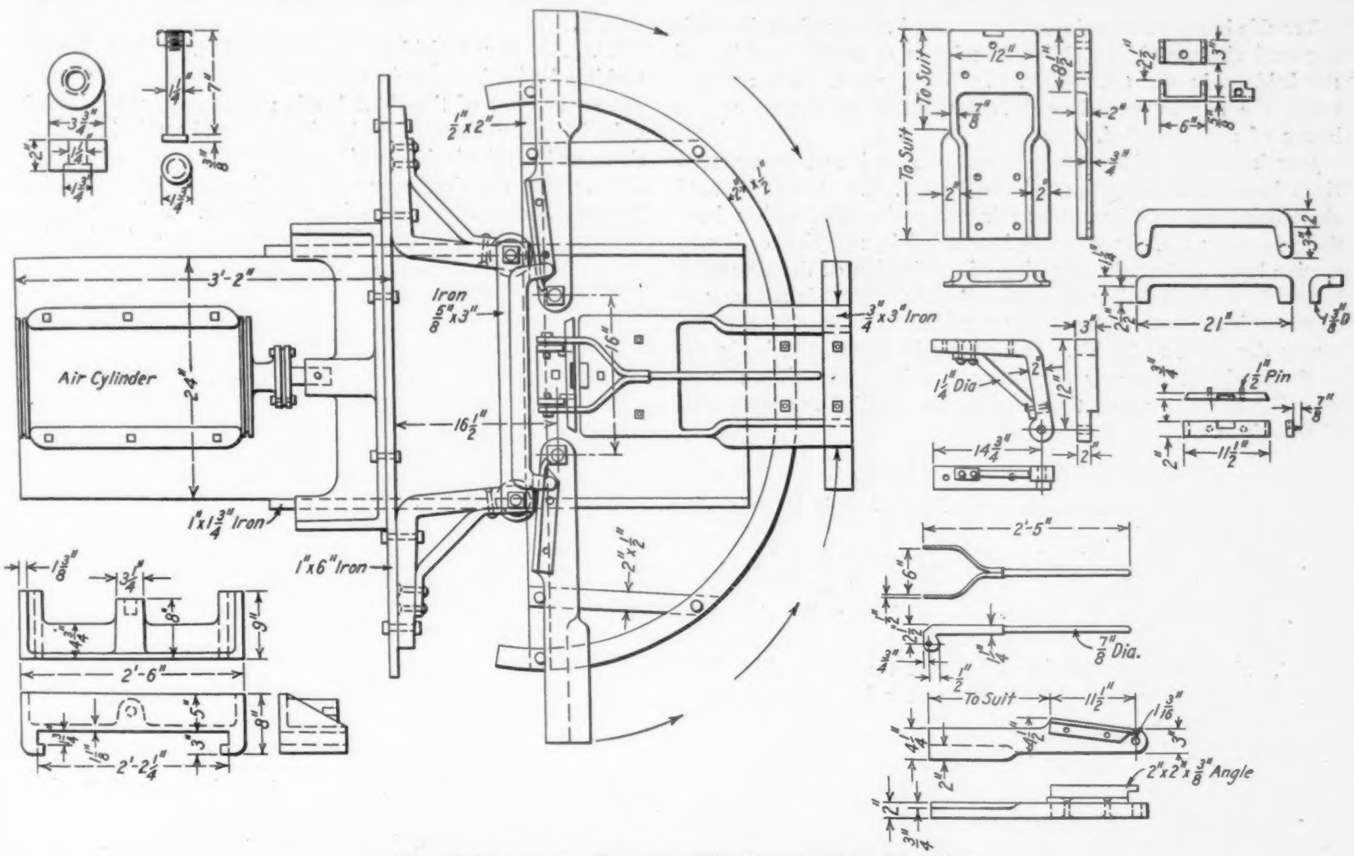


Fig. 12—Device for Forming Sill Steps in One Operation

Fig. 13—Form for Bending Channels Into Stakes for Steel Cars

with the metal electrode and drawing it away, the filling being accomplished by the melting away of the electrode itself. This method will make a softer weld than the process using a graphite electrode and separate filling rod, since there is no tendency for carbon to be carried into the weld. Because of the action of the arc in carrying the metal from the electrode to the work, it is possible to weld on a vertical wall or overhead. This method is largely used in overhead repairs in the firebox and in welding tubes in locomotive boilers. It is of great value where repairs must be made in place. The following is a summary of an actual test made at the Roanoke shops to determine the relative tensile strength of coke butt-welded, electrically butt-welded and new unwelded tubes. There were tested 18 pieces of tubes, six of each kind. The unwelded tubes were found to have an average tensile strength of 37,921⅔ lb. The coke welded averaged 33,236

Fig. 14—Formers for Making Brake Mast Supports

lb., with a corresponding efficiency of 87⅔ per cent, while the electrically-welded tubes had an average tensile strength of 34,020 lb. and an efficiency of 90.6 per cent. The minimum efficiency of any of the six specimens of electrically-welded tubes was 80 per cent. The structure of the material at the weld seems to be

very satisfactory and we are of the opinion that the process possesses decided advantages over the original method of welding in furnaces and fires.

DISCUSSION

Trouble has been experienced by some of the members in welding mud rings, and in welding in tubes, due to the cracking of the bridges in the tube sheet. In heavy work, such as mud rings, the trouble experienced is lamination of the successive layers of metal applied.

Joseph Grine (New York Central) stated that many mud rings have been welded at the Depew (N. Y.) shops, the mud rings being scarfed the same as frames and welded either from the bottom or top. Lamination is avoided by applying each successive layer against the direction of application of the preceding layer. In welding boiler sheets the electric process is superior to oxy-acetylene because the latter generates too much heat and causes the sheet to buckle. In welding in tubes electrically the work should be done by skipping about between points a considerable distance apart, thus tending to equalize the expansion of the sheet.

HEAT TREATMENT OF METAL

No report was presented on this subject, but it brought out considerable discussion.

H. E. Gamble (Pennsylvania Railroad) stated that the Pennsylvania was increasing the heat-treating plant at the Juniata shops. In addition to the larger parts, such as axles, side rods and piston rods, crosshead tees, gib bolts, etc., are all heat treated. Nothing is quenched in oil except very light, thin sheet steel. On all other material flowing water is used and three

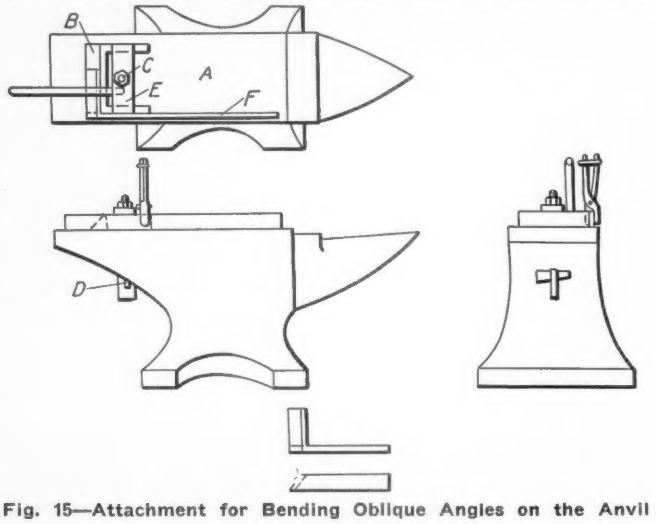


Fig. 15—Attachment for Bending Oblique Angles on the Anvil

heats are recommended. After the forging has been done the parts should be annealed, then the quenching heat taken and finally the drawing heat. The material should be rough turned before heat treating.

The fact was brought out that where heat-treated side rods are used the effect of the heat treatment may be destroyed by bringing the rods into the shop and heating them to straighten or to slightly lengthen or shorten them. As soon as the temperature is raised above that of the original draw point the material will require heat treating again to give it its original properties.

SHOP KINKS

C. A. Slenker (Long Island Railroad): Fig. 10 shows a spring-banding machine with an assembly table attached. This machine was built out of scrap collected at the shops. It has two plungers, one vertical and one horizontal, operated by air pressure. The pressure on each plunger is about 95,000 lb. The frame is built up of two horizontal and two vertical I-beams, the cylinders being secured to the vertical members and the level fulcrums and table to the horizontal members. We also have an oil-tempering tank, to which a small pump is attached and run with air pressure. This pump sucks the hot oil off the top and circulates it in coils in running water and discharges in bottom of tank; the temperature of oil as it discharges is about 130 deg. F.

W. J. Mayer (Michigan Central): Fig. 11 is a former for making brake beam safety straps. This was rather a difficult job on account of the short bends and the amount of stock required between the outside bends. We make this in two operations, making the inside bends first on the top part of the former, then turning the piece over and dropping it down, completing the job on the next revolution of the bulldozer. This former is cast iron, except the male part of the lower former, which is a forging

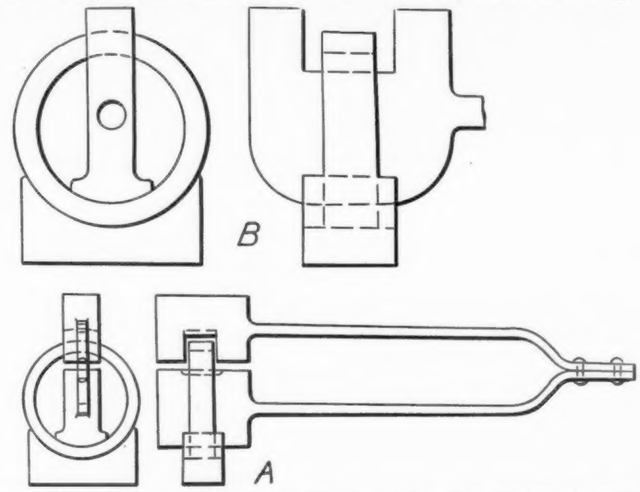


Fig. 16—Device for Forming Rings Under the Steam Hammer

made of scrap steel axle. I have been in a number of shops where sill steps were being made and have examined the formers. The formers illustrated in Fig. 12 will do this job in a satisfactory manner. They are of cast iron with angle iron pieces riveted to the arms and machine steel forgings for the yoke. They are used on a home-made air bulldozer with a 10-in. by 22-in. cylinder, and bend and twist the ends of the sill steps in one operation.

F. P. Deissler (Bessemer & Lake Erie): Fig. 13 shows a form used on our 300-ton forging press to bend channels for stakes on steel cars. The channels are 5 ft. 2 in. long and are 9-in., 20-lb. sections. A channel is placed on the bottom form, flanges down, and is shaped by being pressed into this form with the tongue of the upper die. The finished stake is shown in the photograph. We also use this machine for stripping yokes from couplers, the rivets being sheared by pressure exerted against the coupler shank by the ram of the press. Because of the steady pressure exerted the yoke of the coupler is not mashed or broken and no rivets or tools fly about the shop as is often the case where this work is done under the steam hammer.

Fig. 14 shows formers for making brake mast supports on a bulldozer. This support is ⅝ in. by 2½ in. in section and has several angles, which are difficult to deal with. The straight bar is placed on the former and bent as at *A*. It is then passed to the other side and bent in another former as shown at *B*. The completed brake mast support is shown at *C*, this work all being done at one heat and all pieces being uniform. The formers are made of gray iron with no machine work except facing for bearings and drilling holes for fastening to the machine.

H. E. Gamble (Pennsylvania Railroad): Fig. 15 shows an attachment for use on the anvil in bending bevel angles in one operation. The advantages of this device can well be appreciated when compared with the older methods of doing the work by hand. The construction of the attachment is shown at *A*. The work is formed on a cast-iron block *B*, which is made to the desired angle and is held in place by means of a bolt *C* with a head slotted for a wedge at *D*. The bar of iron is shown in position for bending at *F* and is held in position by the clamp *E*.

Fig. 16 shows a device for forming rings under the steam hammer. The effect of bending in this manner by the hammer and exerting an even blow at each stroke is much better on the material than forming with a mandrel and sledge.

OTHER BUSINESS

The secretary's report showed the addition of 13 new members and a cash balance of $48.48.

The following officers were elected for the ensuing year: President, T. E. Williams, Bettendorf Company; first vice-president, W. C. Scofield, Illinois Central; second vice-president, John Carruthers, Duluth, Missabe & Northern; secretary-treasurer, A. L. Woodworth, Cincinnati, Hamilton & Dayton; assistant secretary-treasurer, George B. White, Missouri, Kansas & Texas; chemist, H. Williams, Boston, Mass.

Chicago received the largest number of votes as the place of meeting for the next convention.

THE ELECTRIC FURNACE FOR REHEATING, HEAT TREATING AND ANNEALING*

BY T. F. BAILY†

In the twenty-five years that have passed since the early and crude development of electric melting and refining furnaces, there have been put into service more than one hundred of these furnaces, ranging in commercial capacity from 1 to 20 tons, and in electrical capacity from 100 to 3,000 kw. Central stations that twenty-five years ago considered 10 cents per kilowatt-hour a low rate are now, with modern equipments of power generation, furnishing electric furnaces with current for less than ¾ of a cent. Electric furnace loads running into thousands of kilowatts, where now there are but hundreds, operating continuously and with power factors closely approaching unity, will undoubtedly cause central stations advantageously located to look with favor upon rates of ½ cent a kilowatt for such loads. As the dominating factor in electric furnace operation costs must always be the cost per kilowatt-hour, the gradual reduction in the cost of electric current will greatly add to the growth of electric furnace loads for re-heating, heat-treating and annealing.

The type of furnace that seems best adapted for re-heating operations is the resistance type, in which the material to be heated is entirely separate from, and independent of, the resistance elements in which the heat is generated by the electric current. A general description of this type of furnace is as follows: Through the side walls of a furnace shell made of suitable refractories are inserted two carbon or graphite electrodes. The inner ends of these electrodes extend into a trough of highly refractory material. This trough is filled with the resistance material itself, usually some form of broken carbon, and makes contact at each end with the electrodes. The outside ends of the electrodes are connected by means of suitable copper terminals and cables to the regulating transformer and switch, by means of which the voltage impressed across the furnace is regulated, the voltage thrown on the furnace having a definite relation to the current flow and heat input. The material to be heated is placed conveniently adjacent, at the side or above or underneath the resistance material and its containers, as the case may be.

In some heating operations the actual cost of heating per ton is less with electric furnaces than with combustion furnaces, while in some heat-treating and annealing operations the precision with which the operations are carried on must be the justification for the higher cost of heating in the electric furnace. In a general way it may be stated that the higher the temperature at which the heating operation is conducted the higher the relative economy in the use of electric furnaces. At the lower temperature there is less difference in the thermal efficiency of electric and combustion furnaces.

The principal advantage of electric furnaces over combustion furnaces for re-heating are more accurate temperature control, non-oxidizing atmosphere, saving in space, elimination of blast or stack, evenness of temperature throughout the heating space, simplicity of control, small amount of heat lost to the surrounding atmosphere, and cleanliness of surroundings.

Electric furnaces of the character described may be controlled with great precision, for the reason that a given input of electric current liberates a given quantity of heat units within the furnace, the transfer of electric current to heat being at 100 per cent. efficiency. The walls and doors of the furnaces are the only means for the escape of heat from the furnace in other than useful work, and this loss remains constant for any given temperature and operating conditions. For a given tonnage of metal to be heated to a certain temperature in a given time, it is only necessary to know the heat absorbed by the metal in coming to the temperature and the heat lost by conduction and radiation from the furnace. The voltage across the furnace terminals is then adjusted so that the kilowatts per hour are just sufficient to deliver this heat. In contrast with this simple method of delivering heat into the furnace, the process of converting chemical energy into heat is not usually conducted at an efficiency closely approaching 100 per cent. Besides this, the stack or discharge flues to the combustion furnace are an ever present means of carrying out what should have been useful heat under ideal operating conditions. Any variation in the supply of air or the supply of fuel in a combustion furnace quickly affects the temperature, and both of these do continually vary, both in volume and pressure.

In order to obtain good commercial efficiency in a combustion furnace, an excess of air over the theoretical amount is required. This excess of air creates an oxidizing atmosphere in the furnace chamber which results in scaling the metal under treatment, resulting in a loss of from one to five per cent., depending upon the type of combustion furnace, the temperature, and the man operating the furnace.

As the heat from the resistance units is thrown on the hearth almost entirely by radiation, the temperature of the furnace is more readily kept uniform over the entire area than in combustion furnaces where the heat is delivered to the hearth by the impinging heated gases or products of combustion. Another feature leading to evenness of temperature throughout the electric furnace is that the resisters of the electric furnace may be run at only a comparatively small temperature above that of the hearth of the furnace, while the combustion furnace, for instance, in an annealing operation, requires that the incoming gases from the combustion chamber must of necessity be several hundred degrees higher than the temperature of the furnace.

The actual theoretical heat required expressed in kilowatt hours her ton of metal is as follows for heating to the temperature given:

Material	Deg. F.	Kw. Hrs. Per Ton
Iron	2,200	230
"	2,000	215
"	1,800	200
"	1,650	170
"	1,500	150
"	1,250	115
"	900	75
Copper	1,400	90
Brass	1,300	85
Aluminum	950	140
"	750	110
Silver	1,300	50
German Silver	1,300	75

The thermal efficiencies of electric furnaces vary greatly with the size and capacity in tons per hour. The wall loss on a forging furnace of 60 kw. capacity heating 250 lb. of steel per hour to 2,200 deg. F., will be approximately 30 kw., showing a thermal efficiency of 50 per cent. A furnace of one ton per hour capacity for 2,200 deg. will show an efficiency of 75 per cent.

*From a paper read before the Engineers' Society of Western Pennsylvania at Pittsburgh, April 6, 1915.

†President of the Electrical Furnace Company of America, Alliance, Ohio.

In annealing work a furnace of 100 kw. per hour capacity will heat 600 lb. of metal to 1,650 deg. with an efficiency of 50 per cent; while a furnace of 600 kw. capacity, heating three tons of steel per hour, will show an efficiency as high as 90 per cent. All the above figures are typical for the usual classes of work handled in the capacity named.

The rapid growth of the practice of heat-treating and a realization of the precision with which this treatment must be carried on in order to secure uniform results, has opened a particularly desirable field for the electric furnace, especially as the electric furnace can be more accurately controlled and a greater uniformity of heat throughout the furnace maintained in commercial operation than with combustion furnaces. A comparatively slight variation in either blast pressure or fuel supply in a combustion furnace very quickly affects the ruling temperature, while in the electric furnace, owing to the comparatively great mass of heated refractory material of walls and roof acting as a heat storage or accumulator, the variation in temperature is reduced to a minimum. In practice the current may be off for periods of an hour at a time without affecting the temperature more than a few degrees. This type of furnace may be described as follows: In the usual steel shell is constructed an arched roof of fire brick, so arranged as to reflect the heat radiated from the resister troughs onto the hearth located between the two resister units running lengthwise of the furnace. The material to be heated is handled through the door or doors of the furnace located in the end walls. The hearth, if not subject to mechanical abrasion, is made of suitable fire brick. Where the abrasion is likely to be severe, cast iron plates replace the fire brick. A heat balance sheet of a furnace of this type of 100 kw. capacity and the hearth area 5 ft. by 6 ft., and heating 600 lb. per hour to 1,650 deg. F., will show the following balance:

Heat absorbed by the metal	50 kw.
Heat lost through the walls	35 kw.
Heat lost through the doors and door openings, due to the frequent charging and withdrawing	15 kw.

For furnaces of more than one-half ton per hour capacity, and for higher thermal efficiencies, the continuous type of furnace is desirable. The material, if of uniform section, is pushed through the furnace by direct application of the pusher to the material to be heated. If the parts are small or liable to buckle if direct pressure is exerted on them, they are placed in pans or steel boxes, these containers being pushed through one at a time. If the material is in the form of rods that may be handled through the furnace lengthwise, as, for instance, copper and brass rods or tubes, this material may be placed on steel pans and drawn through the furnace by means of hook and chain, as is common in brass mill practice. A typical furnace of the continuous type for annealing German silver or brass stampings in steel pans has a hearth 15 ft. long by 2 ft. wide, and a rated electrical capacity of 200 k.w. A mechanical charger operated by a motor-driven winch with hand operated clutch pushes the pans in through the charging door one after another, seven pans being in the furnace at one time. The pans passing through the furnace are supported by a hearth made of cast iron grids, each 2 ft. square. The pan when discharged is dumped automatically into a water sealed discharge hood. The metal under treatment falls into a tank of either clear water or pickling solution, depending upon the cleanliness of the material before it is charged. Thus in this furnace the material is not exposed to the atmosphere at any time after entering until taken cold from the quenching tank. This entirely eliminates the possibility of oxidation as the furnace itself has a reducing atmosphere. A heat balance sheet of this furnace heating 1,500 lb. of steel per hour to 1,650 deg. will show the following:

Heat absorbed by 400 lbs. of pans	34 kw.
Heat absorbed by 1,500 lbs. of metal	127½ kw.
Heat lost through walls and doors	30 kw.

The advantage of this type of furnace over the non-continuous furnace is a lower labor cost and the fact that the material when brought to the desired temperature may be more quickly removed, eliminating largely the danger of over-heating, and at the same time allowing the material under treatment to be brought to temperature more gradually.

The type of furnace best adapted to heat-treating which requires precision, is the automatic continuous type, wherein the material under treatment, when brought to the predetermined temperature, is automatically discharged either into the air or into some quenching medium. This method of operation reduces the human element and the chance of error to a minimum. The only part of the operation dependent on the operator is the placing of the material to be heated on the charging platform. When the material at the discharge end of the furnace reaches the maximum temperature, a special pyrometer closes an electrical circuit, which in turn closes, through a suitable relay, the solenoid-operated radial dial switch; the various electrical circuits in turn operate the doors, pusher and quenching apparatus.

The greatest objection to heat-treatment as generally practiced to-day with combustion furnaces, is due to the inability to obtain duplicate results. The automatic equipment just described eliminates the uncertainties of non-automatic equipments and enables heat-treating to be done with as great a precision as it is possible to measure. While with hand operation it is possible to obtain excellent results in actual practice at times, a considerable portion of the material treated will fall below the standard as determined by physical tests.

In heat-treating the saving in operating cost of electric furnaces over combustion furnaces in most cases must come in the elimination of oxidation—as, for instance, on high-grade steel, brass and non-ferrous metals, eliminating large expense in acid, and in labor for the pickling operation. In addition to this, the advantage which outweighs, perhaps, all others, is the precision with which electric heat-treating may be done. It is obvious that it is useless to heat-treat a series of parts that may go to make up a steel structure, as a bridge, a line of rails, or a set of springs or axles of a locomotive, if the method of heat-treatment is such that dependence cannot be fully placed on the gain in physical properties. The failure of a single member of the bridge or a single rail or a spring or axle, is almost certain to cause a catastrophe; hence, without absolute precision in temperature and method for producing that temperature in every piece alike, vital parts of a structure or a machine must be figured on the basis of untreated parts, necessitating a greatly increased weight over that of a design relying on the greater strength of heat-treated parts.

The user of steel to-day is willing to pay the additional cost for the additional physical qualities to be obtained by proper heat-treatment; but he has never been willing and never will be willing to pay for the so-called heat-treatment that has in too many cases consisted of simply putting the material through a furnace. When the engineer realizes that for an additional cost of from $2 to $3 per ton he can with certainty get the full value of results possible with heat-treatment, the demand for heat-treated material will be a great many times larger than it is to-day.

Petroleum in Chile.—The existence of petroleum, it is reported, has been definitely established near Punta Arenas and to the northwest of Tierra del Fuego, Chile. The frequency of the emanations of natural gas makes it probable that the deposits are large.—*The Engineer.*

Indian Manganese Ore.—The exports of manganese ore from India in April this year were 16,269 gross tons, of which 12,969 tons went to Great Britain and 3300 tons to France. In April, 1914, the exports were 65,533 tons, making the decrease this year 49,264 tons, or 75.8 per cent. Since January 1, no ore has been sent from India to the United States.—*The Engineer.*

NEW DEVICES

BERDAN BRAKE RIGGING

The illustrations show a new type of brake rigging invented by E. G. Berdan, stationmaster at the LaSalle Street Station, Chicago, of the New York Central Lines West. It is designed for the purpose of eliminating the use of brake beams. Fig. 1 shows the top view of the device as applied to one side of the truck. Fig. 2 shows a half section through the gear and racks that operate the shoes, and a section through the connection to the brake rods. The pressure from the brake cylinder is transmitted through the regulation foundation gear to the brake rod, which is connected by means of a link to a crank on the gear shaft. As this shaft is turned the gear will rotate, driving the top and bottom racks, to which the brakeshoes are attached, outward, forcing the brakeshoes against the wheel. The mechanism is supported on the truck spring plank, a special housing being required to hold the gears and the rack. With the rack above and below the gear it will be seen that as the gear rotates, one brake shoe will act as an abutment against which the gear operates for forcing the other shoe against the wheel.

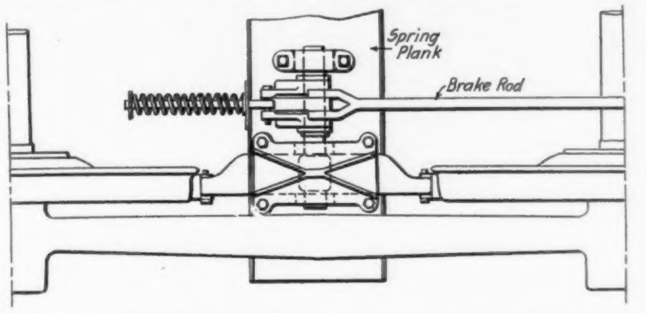


Fig. 1—Top View of the Berdan Brake Rigging

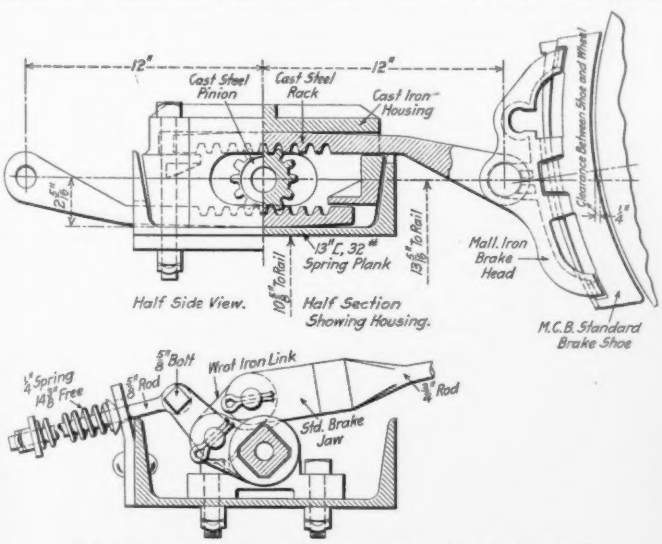


Fig. 2—Section Through the Berdan Brake Rigging

Provision is made for allowing for differences in wear of the brakeshoes or the loss of a shoe. The gear shaft on its inside end is supported in a curved bearing as shown in Fig. 1, which permits the shaft moving out of alinement. The outside bearing of the gear fits in a slotted hole. The change made in the gear and racks to accommodate this movement is shown in Fig. 3. It will be seen that both the gear and the racks have their teeth tapered each side of the center line, thus providing a free working arrangement for all positions of the gear shaft. A ¼-in. coil spring is used, as indicated in Fig. 2, for bringing the mechanism back to normal position, which provides a ¼-in. clearance between the shoe and the wheel. The brake rods are provided with turnbuckles for the purpose of giving close adjustment, thereby overcoming lost motion and maintaining the proper piston travel. This gear has been in experimental service and is found to work satisfactorily.

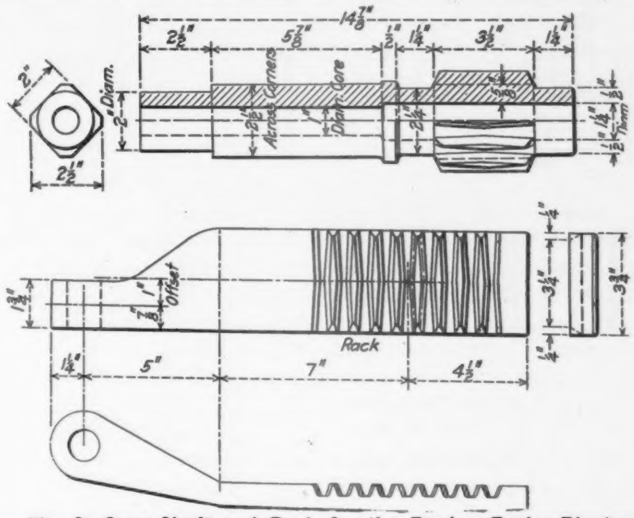
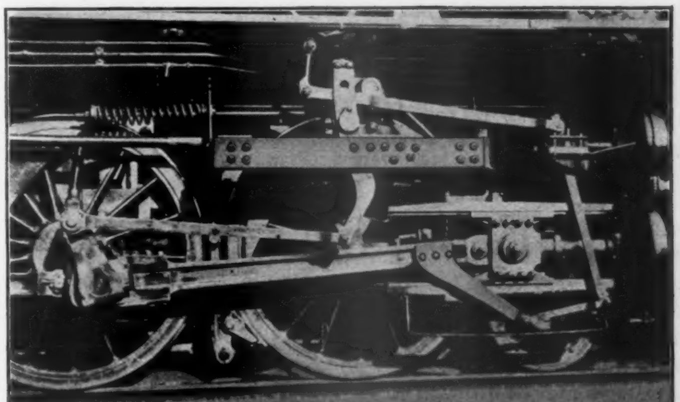


Fig. 3—Gear Shaft and Rack for the Berdan Brake Rigging

KINGAN-RIPKEN VALVE GEAR DEVICE

The photograph shows a new feature that is applied to outside valve gears for the purpose of overcoming the slow action which the combination lever imparts to the Walschaert and similar valve gears. The bottom connection to the combination lever is made to the main rod, as indicated in the illustration, instead of to the crosshead, as is customary. This gives the combination lever a different movement, in that it responds to the up and down movement of the main rod. As the piston is on the last half of the stroke this causes the release, compression and pre-admission to occur later in the stroke with the same cut-off, thereby giving a longer period of expansion, less compression and less pre-admission with the same amount of lead. At the end of the piston travel, the main rod being in the center of its oscillatory movement, the arrangement will have no effect



Application of the Kingan-Ripken Valve Gear Device

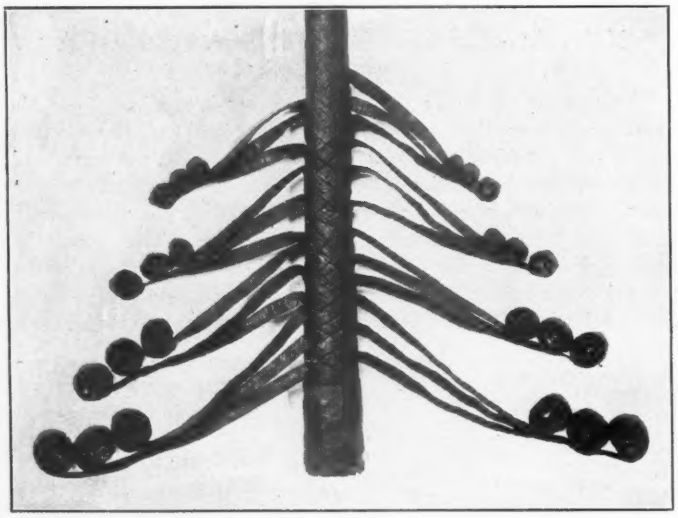
upon the lead, but as the piston leaves the end of its travel and the main rod again assumes an angle, a quicker, larger and longer-maintained port opening is obtained with the same cut-off, and also a longer cut-off with the reverse lever in the same position. It is also claimed that this arrangement will give a more even distribution of steam to the cylinders; it will permit more uniform valve events and allow the use of a shorter cut-off with its consequent saving of steam. This fact, combined with the longer maximum cut-off obtainable, should provide a quicker starting, faster, more powerful and more economical engine.

A number of locomotives on the Minneapolis, St. Paul & Sault Ste. Marie have been equipped with this device. The patents are controlled by the Kingan-Ripken Company, 2627 Lincoln St., N. E., Minneapolis, Minn.

AIR BRAKE HOSE

A new method of rubber hose construction, known as the Subers process, has been developed by the Goodyear Tire & Rubber Company, Akron, Ohio, and applied in the manufacture of standard M. C. B. air brake hose. This process makes possible the production of a hose of uniform thickness and eliminates the tendency to twist or contract under pressure.

In the making of what is termed wrapped hose, the fabric is cut on the bias, overlapped and wrapped directly over the tube. The lap of the fabric in hose of this type varies the thickness often as much as 1/32 in., and when cut through, a section of the material clearly shows that the fabric is not thoroughly impregnated with the rubber. The wrapping material in the Subers process consists of parallel strands or cords combined into strips, each strip consisting of about 288 strands and being approximately 1/16 in. thick by ½ in. wide. Every strand is separately coated



Method of Wrapping the Tube in the Subers Process

with rubber compound, which binds the strands in each strip firmly together, the impregnation of the fabric being thus very complete. The strips are wound spirally about the tube or lining of the hose, there being two complete layers in each direction. The strips in each layer are separated by a space equal to their own width and there is no overlapping. The manner in which the strips are applied will be clearly understood by referring to the illustration.

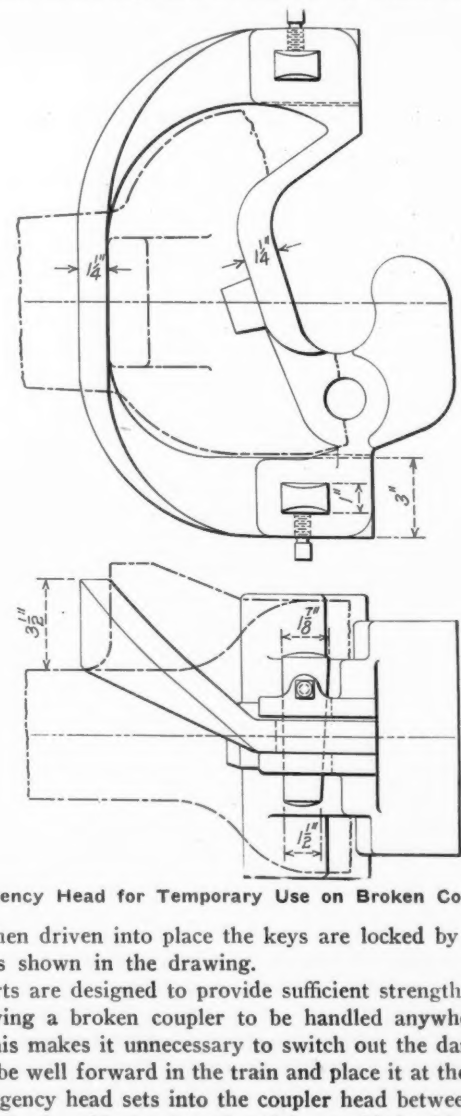
Hose of this construction shows a specially high bursting pressure and the distorting effect of the pressure is minimized. The elongation per foot per 1,000 lb. pressure will average about ⅛ in., with an expansion of about 1/16 in. in the diameter, there being no twisting or contracting. Until a pressure of 1,300 lb. has been reached, however, but little change takes place.

At the present time the manufacturers are confining their production of this type of hose to the standard air brake hose in lengths of 22 in., but later expect to adapt the process to the manufacture of car heating steam hose, pneumatic tool hose, etc. The air brake hose now being manufactured conforms to the Master Car Builders' specifications presented at the last convention of the association. It is being used by several railroads.

EMERGENCY COUPLER HEAD

The drawing shows a coupler head for emergency use which has recently been brought out by Frank B. Hart, Railway Exchange Building, Chicago. This head is intended to overcome the troubles incident to the use of heavy chains between cars in a train that has parted through failure of any vital part of the coupler in front of the striking horn.

The emergency head consists of a dummy knuckle cast integral with a 1¼ in. shell or plate, both sides of which conform to the contour of the coupler head. One side of this plate is placed on the coupler head and the other forms a standard contour for the mating coupler on the adjacent car. Lugs are cast on either side of the dummy head, in which are cored elongated slots. The ends of a yoke which passes back of the horn of the coupler enter the slots in the lugs and are secured by means of tapered



Emergency Head for Temporary Use on Broken Couplers

keys. When driven into place the keys are locked by means of set screws shown in the drawing.

The parts are designed to provide sufficient strength to enable a car having a broken coupler to be handled anywhere in the train. This makes it unnecessary to switch out the damaged car should it be well forward in the train and place it at the rear end. The emergency head sets into the coupler head between the lugs to which the knuckle is pivoted and is provided with a vertical pin hole so that in case these lugs are not broken the pin may be inserted, thus relieving the keys of a portion of the load.

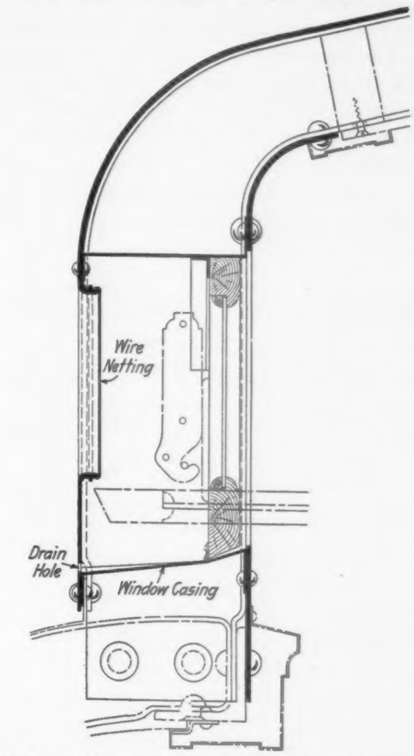
Such a device has several advantages over the chains which are commonly used in emergencies of this kind. It is lighter, much

more compact and may be much more quickly applied and secured. It eliminates the excessive slack with the attendant destructive effect to the equipment and lading and it permits the recoupling of the air brake hose, thus maintaining full air brake control of the train back of the broken coupler without switching out the damaged car.

ROOF CONSTRUCTION FOR PASSENGER CARS

In building passenger car roofs of the clere-story type there has always been more or less difficulty in securing a substantial upper deck construction which may be cheaply built and in which a satisfactory casing is provided around the deck sash and screens. The accompanying drawings show a type of construction recently patented by Otto B. Johnson, New Glasgow, Nova Scotia, which is designed to overcome these difficulties and to simplify the securing of weather-proof connections between the lower roof and the deck.

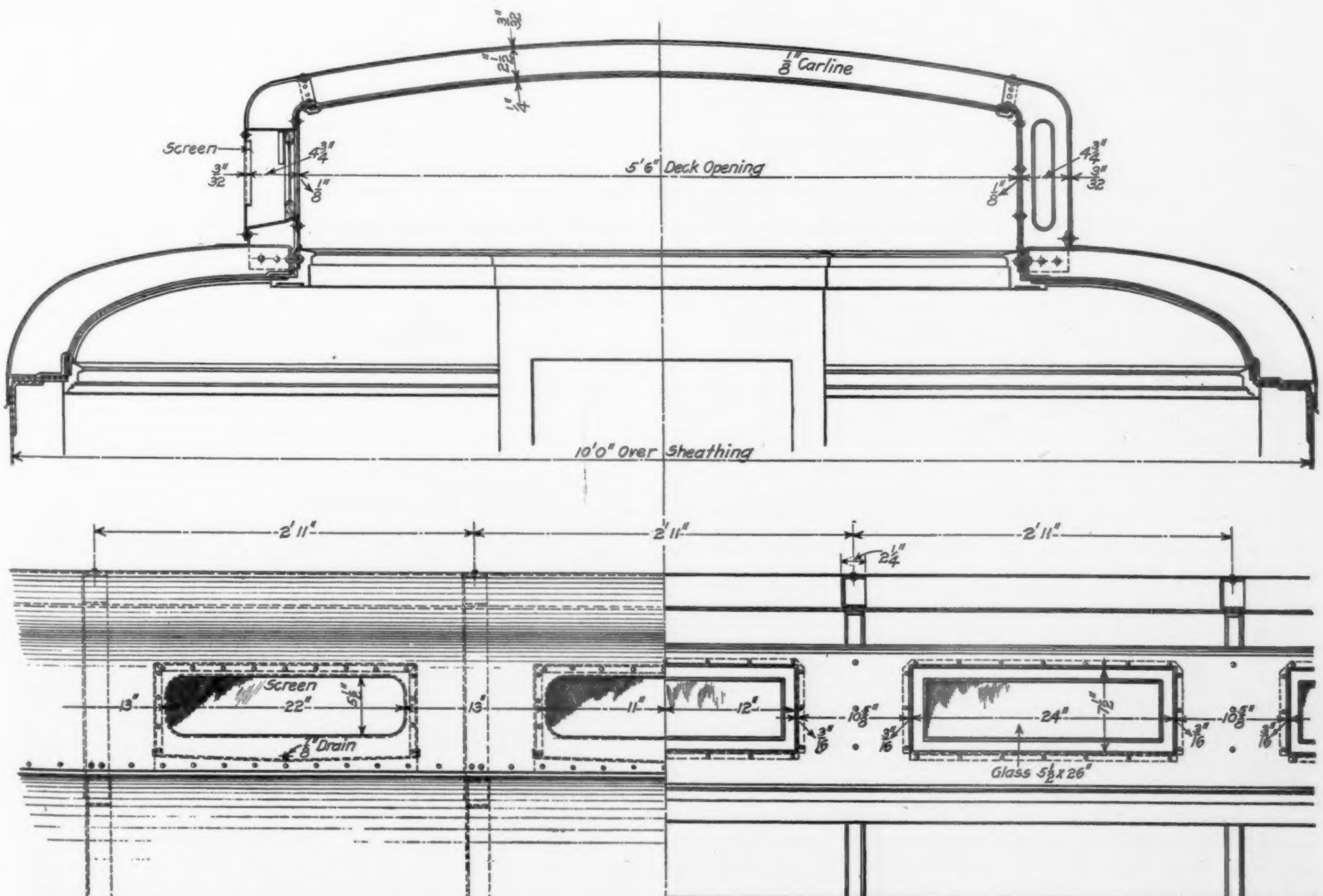
In this construction the roof frame consists of special pressed steel channel sections, forming the carlines and upper deck posts, to the outside of which are fastened the roof sheets and to the inside of which the interior finish is applied. The sides and roof of the upper deck are covered with continuous sheets formed to the contour of the roof. Flanged openings are provided in these sheets for the ventilator screens, which are secured against the edge of the flange by means of a wire clamp. The deck posts are secured at the bottom to the upper ends of the lower carlines and to the deck sill angle, the three pieces being securely riveted together. The upper ends are bent to form a connection with the upper carline. With this construction the soldering of flashing around the posts is avoided, which is unsatisfactory and expensive, and continuous roof sheets from lower deck to lower deck may be used. The lower roof sheets may be formed with vertical flanges at the sides of the deck and



Detail of the Deck Sash Casing and Flashing

directly riveted to the upper roof sheets.

Instead of having a continuous flashing and sash frame



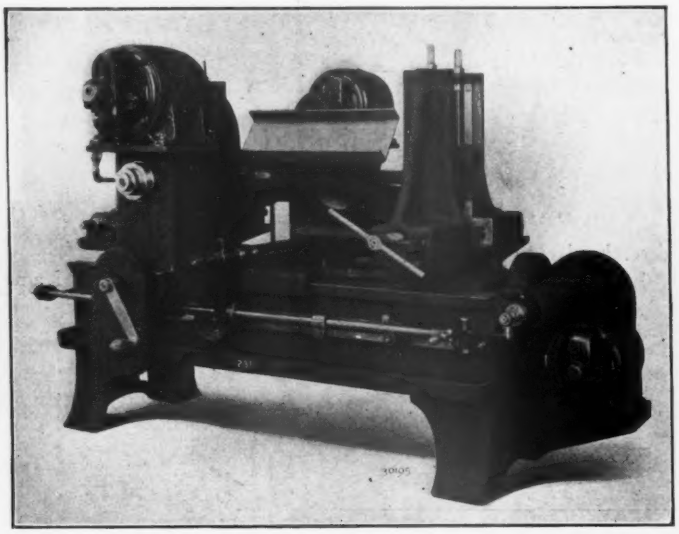
Simple Weather Proof Clere-Story Roof Construction

throughout the length of the deck a combined flashing and frame is provided for each opening which completely encloses the space between the screen and the sash. The remainder of the space between the sheathing and the interior finish of the car is thus closed from communication with the outside air and serves as insulation. The bottom of the window casing slopes outward and toward the middle and drains through a small hole in the outside sheet.

This construction is claimed to make possible a considerable saving in weight as compared with the usual type of clere-story roof.

COTTER AND KEYSEAT DRILL

The machine shown herewith is especially adapted to the drilling of spline and keyseats in shafts, piston rods and locomotive crossheads. It may also be used for drilling and mortising the holes in side rod stubs at one setting. It is manufactured by the Niles-Bement-Pond Co., New York, and is furnished in two sizes, with either one or two heads. The illustration shows the



Machine for Drilling Spline and Key Seats

larger size machine with two heads, with a large crosshead set up for drilling the key slot.

The chuck jaws in this machine will take work up to 10 in. in diameter and it has a spline cutting capacity up to 36 in. long, 2½ in. wide and 16 in. deep. For large work the machine may be equipped with sliding centers which will take pieces up to 19 in. in diameter and 42 in. long.

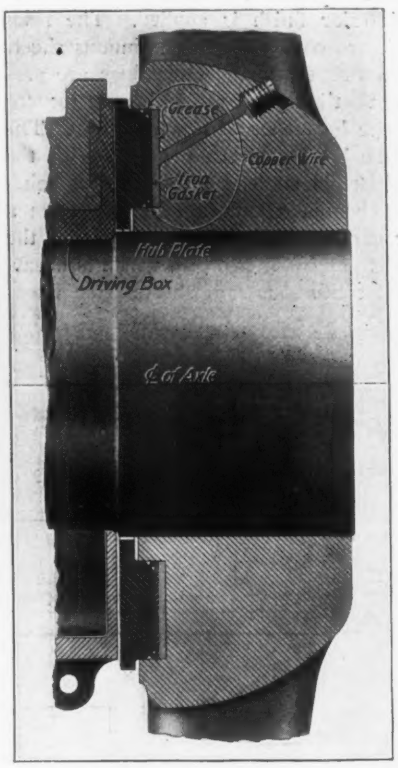
Each spindle is driven by a separate motor, which is mounted on the head. The heads may be moved on the carriage by either hand or power cross-feeds and a reciprocating longitudinal traverse of the carriage is provided on the bed of the machine. This is reversed automatically by means of trips, the location of which is adjustable on the reversing rod, shown in front of the bed of the machine. Variable power feeds are provided on the spindles and an automatic stop throws out the feed at any desired depth of cut. The traverse of the carriage on the bed of the machine is driven by a separate motor, which is so wired in connection with the spindle driving motors that it will be stopped when the latter are shut off.

By using both heads at the same time it is possible to drill slots completely through the work, the two heads cutting from opposite sides. When near the center of the work the automatic stop will throw out the feed on one of the heads, while the other continues to cut through the piece.

As shown in the illustration the machine is provided with universally adjustable chuck jaws, but it may be furnished with them located at a fixed height where desired. For work which cannot be supported in jaws an adjustable table is supplied.

ADJUSTABLE HUB PLATE

The illustration shows an improvement in the Smith adjustable hub plate, for which patents have recently been granted. This plate is maintained at the proper distance from the hub by means of compressed grease, the adjustment being made by screwing in the grease plug shown on the outside of the wheel hub. The adjustable plate is forced into a recess in the hub, which is 1 in. deep and varies from 2 in. to 3¼ in. in width, according to the size of the wheel. It may be applied either by hammering or under a press, about 20 tons being required to press the plate into place. The new feature is the method of preventing the grease from leaking past the plate and relieving the pressure which would affect the adjustment. The plate is beveled to receive a No. 9 gage copper wire, which is placed around the outer and inner edges of the plate, as indicated in the illustration. This wire is soldered so as to be continuous. A No. 24 gage iron liner holds the copper wire in place as the hub plate is forced outward by the grease pressure. As the hub plate is forced into a bearing in the hub the copper wire assumes a rectangular section, thereby making a more perfect seal. The plate is kept from rotating by six ¾-in. dowel pins screwed into the plate and fitting into holes in the wheel hub.



Improved Smith Adjustable Driving Wheel Hub Plate

By the use of this device the lateral may be maintained constant and it may be taken up with comparatively little labor, it being possible to adjust all the wheels in from one to three hours. This eliminates the necessity of dropping the wheels and relining the face of the driving boxes when the lateral becomes too great. By the use of this hub plate much less lining material is required on the face of the driving box, inasmuch as the hub plate is ½ in. thick on its outer flange. Excessive wear on the driving box liner is also eliminated as the lateral may be properly maintained and thus prevent pounding, due to the excessive lateral, which many times breaks away the driving box liner. It has also been found unnecessary to reline the boxes between shoppings. The plate can be applied to old as well as new locomotives. The right for the use of the plate is sold by the Smith Locomotive Adjustable Hub Plate Company, Pittsburgh, Kan.

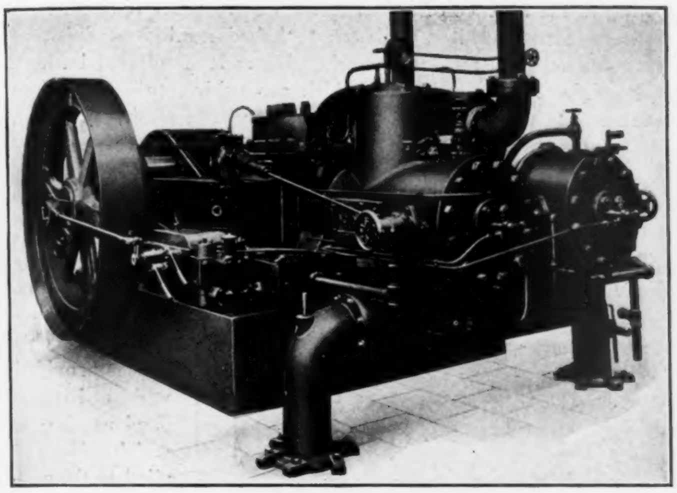
A CORRECTION

In the August number was published an article entitled "Simple Coupler Release Rigging," from which the name of the manufacturer of the device described was inadvertently omitted. The device is the Singlelink release rigging, and is manufactured by the National Railway Devices Company, Chicago.

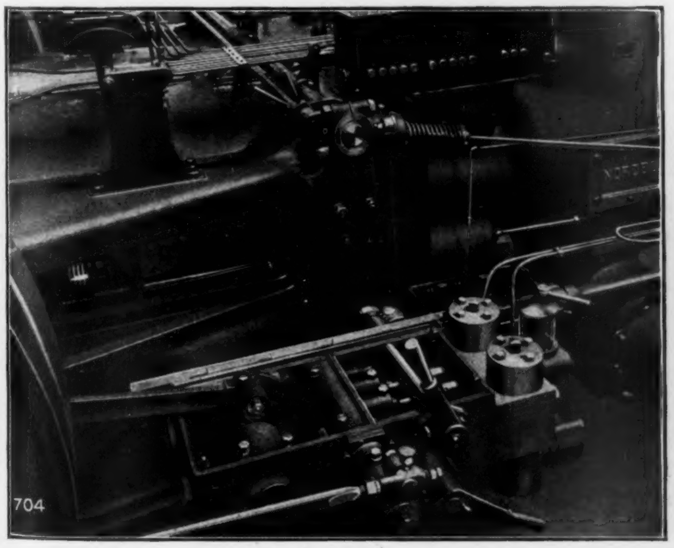
HIGH COMPRESSION OIL ENGINE

The Nordberg Manufacturing Company, Milwaukee, Wis., now builds a high compression oil engine, in sizes of from 50 to 200 hp., designed to meet a widespread demand for an engine as simple as a slide valve steam engine. There are many small steam plants burning oil, where the fuel totals 2 to 4 lb. per hp. An oil engine delivers the power on .4 to .6 lb. of oil, but nevertheless is worthless to a plant owner unless it is simple and reliable and can be operated by an ordinary mechanic.

The accompanying photographs illustrate the 200 hp., 270 r.p.m. size, Nordberg high compression oil engine. These engines resemble Diesel engines insofar as concerns the method of ignition by the heat of the highly compressed air. The compression pressures are about 450 lb., but a three-stage high pressure air compressor for 1,000 lb. pressure for injecting and atomizing the fuel is not used. The fuel is injected mechanically by a small pump and discharges through a new type of atomizing head which successfully subdivides and atomizes the oil. The success of the engine is due largely to the effective working of this atomizing head. The elimination of the high pressure compressor with its intercoolers simplifies the installation in small plants, for which these engines are designed.



Nordberg 200 hp. High Compression Oil Engine



Fuel Injection Pumps, Strainer Tank and Air Starting Gear

The engine is of the two-cycle design, and all valves, cams, springs and valve gear have been eliminated, contributing further to the item of simplicity and ease of attendance and inspection. The head is a simple symmetrical casting and is not subject to cracks due to unequal expansion strains. There are no valves in the head. The only valve on the engine is a piston valve for scavenging air, located above and between the cylinders. One valve controls the scavenging air for the two cylinders. Air is compressed on the crank side of the piston and by-passed to the head end shortly after the uncovering of the exhaust valves. This forces the burnt gases out of the cylinder and fills it with fresh air. Compression and combustion then occur as in any two-cycle engine. The air intake is through the vertical pipes above the engine, and exhaust through the pipes going through the floor.

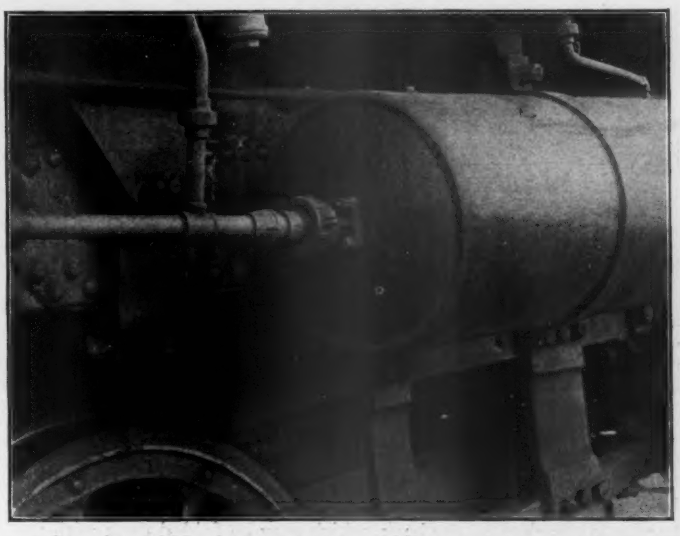
For the 200 hp. twin engine a special automatic starting arrangement has been designed, simplifying the operation so that the engine may be brought up to speed in less than a minute.

The fuel pumps run in a bath of lubricating oil. The oil is drawn from the storage tank to a small strainer box located to the right and behind the pumps, from which it flows to the main fuel pumps. A small heating coil, through which heated jacket water circulates, is contained in the main oil compartment of the strainer box to insure free flow of very viscous oils. The pumps are operated by cams driven by an eccentric and deliver a quantity of oil in excess of that required for maximum load, the governor acting to by-pass more or less of the fuel, depending on the load obtaining. The by-passed oil is discharged through the sight glass and gives the operator a quick check on the working of each of the pumps. The governor is of the flywheel design and gives a regulation of 2 per cent. from no load to full load. From the fuel pumps the oil is discharged through small pipes to the atomizer heads bolted to the main cylinder heads.

The lubricating system of the engines is entirely automatic, oil being fed from a central pump driven from the scavenging valve eccentric. Cylinder oil is pumped to the scavenging air valve and to the main cylinders. Bearing oil is pumped to all main bearings, to the crosshead pins through trombone oilers and to all auxiliary bearings. The cranks are enclosed by polished iron guards and the oil accumulates in the crank case from various parts of the engine and is drained to a filter and returned to the lubricator.

BALL JOINT CONNECTION FOR MAIN RESERVOIRS

The breakage of air pipes where they screw into the main reservoir on locomotives has always been a source of annoyance and expense, and to overcome this special brackets have been designed and are in quite general use to rigidly support the reser-

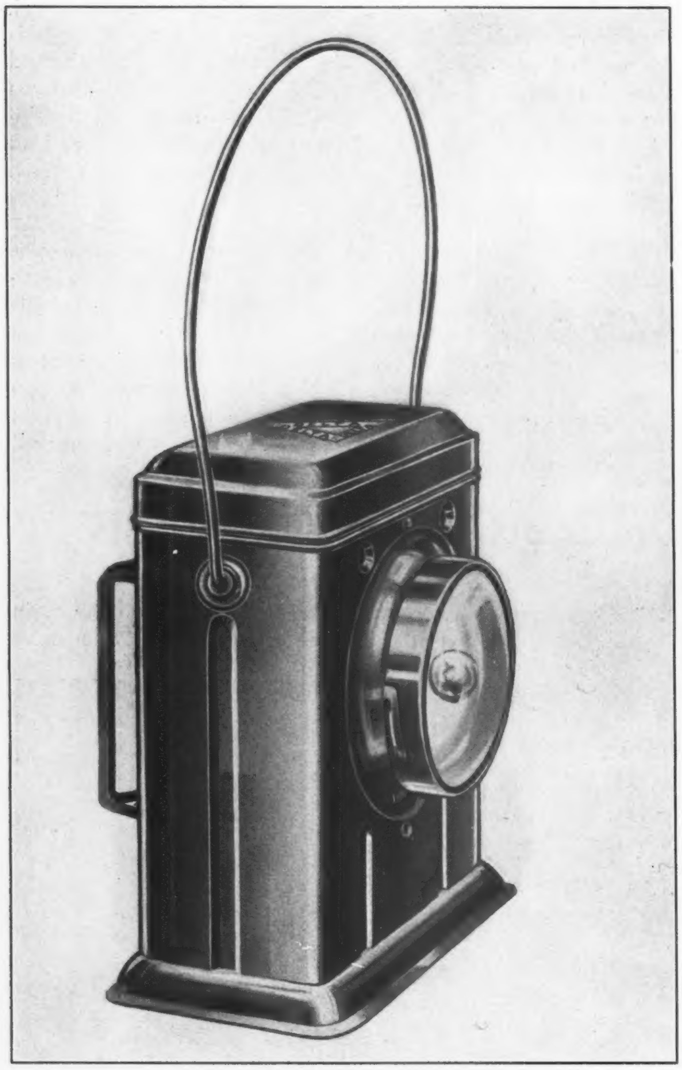


Flexible Joint with Flange Connection for Main Reservoirs

voir. The greater part of the trouble is caused by vibration while the engine is running and in order to eliminate such breakages the Barco Brass & Joint Company, Chicago, has developed the flexible joint shown in the engraving. This connection is made with a flange attachment to the reservoir which, it is claimed, gives better service than when a nipple is used. This type of reservoir connection has now been in successful service for about three years.

ELECTRIC HAND LANTERN

An electric lantern of substantial construction has recently been placed on the market by the Delta Electric Company, Marion, Ind. It is designed to withstand severe service, such as imposed upon the various classes of oil lanterns now in general commercial use. The case is formed from cold rolled steel, ribbed to add strength, and the bottom is provided with a one-half-inch flange extending completely around the lantern. No solder has been used in the construction and all parts are thoroughly riveted together. It is provided with an extra large drop bale handle, suitable for throwing over the arm and a grip handle is attached to the back, which may be folded flush with the back of the lantern when not in use.



Delta Electric Lantern.

The lantern is fitted with a three-volt tungsten bulb and lighted by batteries which will run from 100 to 150 hours in actual use. The batteries are connected to the lamp by flexible wires which are secured with binding screws and may be replaced when worn. The reflector case is drawn out of the body of the lantern, thus giving protection to the vital parts of the lantern, the reflector, bulb and contacts. The reflector is drawn from sheet phosphor bronze and has three coats of heavy silver, polished to a mirror finish. A concave-convex lens, 3 in. in diameter is placed in front of the bulb. The switch is located in the back of the lantern in a convenient and well protected place, it being so arranged that it does not project beyond the surface of the lantern.

The light is thrown evenly through a hemi-sphere so that if the lantern is hung on a well it will throw light on all sides of the room. It may be provided with a spot light reflector if desired. Owing to the absence of solder in the construction of the case, it is possible to give it a high grade baked semi-gloss finish of black enamel with nickle plate trimmings. It stands 7¾ in. high and weighs 16 oz. All parts which are subject to wear are so constructed that it is possible to replace them at a minimum cost.

JOURNAL JACK

The accompanying illustration shows a journal jack, recently placed on the market by the Parsons Metal Products Company, Indianapolis, Ind. This jack is provided with a long pawl as shown, which is applied to the projection of the car wheel rim, thus keeping the wheel on the track while the box is being lifted for the application of a new brass. This jack is made entirely of steel, and weighs 29 lb. complete. It is 10½ in. high when closed, and 15½ in. high when extended to the limit. It has a capacity of 25 to 30 tons. Its construction is simple, only nine separate parts being used.

Parsons Journal Jack

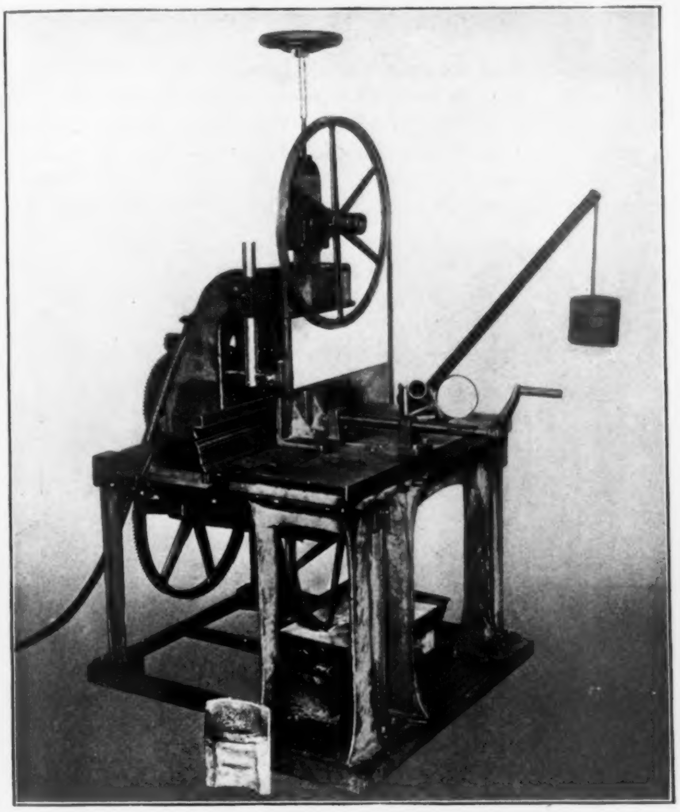
METAL BAND SAW

The illustration shows a metal cutting band saw which has recently been placed on the market. It is designed to cut off stock from ⅛ in. to 8 in. in diameter, and will handle 8-in. I-beams or square sections. The machine is of simple construction throughout and may be operated by unskilled labor.

The table is 26 in. high, and is stationary, the saw being moved to the work. The frame carrying the saw wheels and driving mechanism is mounted on guide bars upon which it slides, and may be operated either by hand or automatic gravity feed, the pressure being varied by the number of weights hung on the operating lever. The saw guide is conveniently located and easy to adjust. The tightening of the blade is accomplished by the hand wheel shown on top of the machine. When motor driven, the motor is mounted on the frame of the saw, as shown

in the illustration, making the machine entirely self-contained.

Light material, such as tubing, metal moldings, etc., are cut very rapidly and accurately. For special work requiring a flat



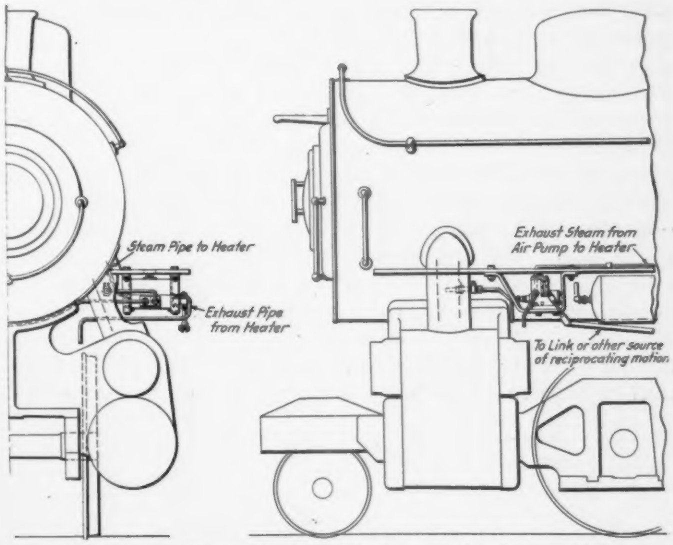
Metal Cutting Band Saw

table the back may be removed. The saw is manufactured by H. C. Williamson, 1840 West Lake street, Chicago.

DOUBLE ACTION FORCE FEED CYLINDER LUBRICATOR

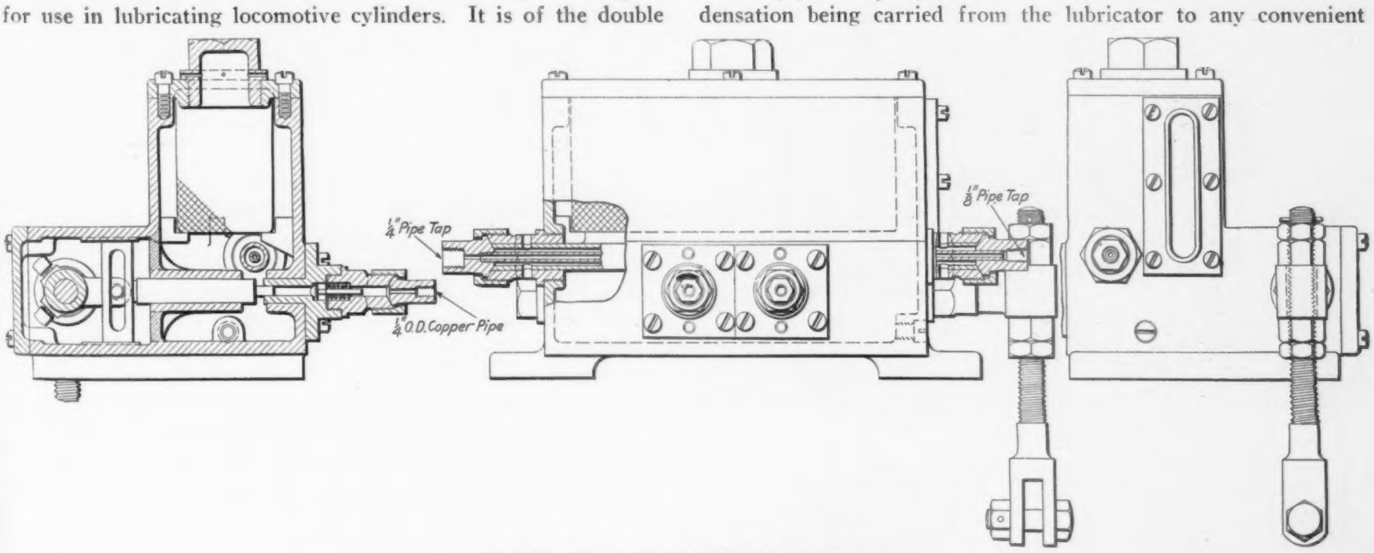
The force feed lubricator shown in the drawings is designed for use in lubricating locomotive cylinders. It is of the double action directly operated type and is being manufactured by the Nathan Manufacturing Company, New York.

By referring to the detail drawing of the lubricator it will be seen that it is directly operated without the use of a ratchet. The lever attachment to the lubricator is designed to be connected in any suitable manner with a reciprocating part of the engine, the length of the arm being adjustable to suit the amplitude of the motion. The oscillating shaft to which the lever is attached is provided with arms in the lubricator which are pin connected to slotted crossheads on the ends of the pump plunger, the arrangement being such that for each complete cycle or revolution of the engine two complete cycles of the pump plungers are produced. Oil is thus forced into the steam passages twice during each revolution by the use of but one plunger for each cylinder. The plunger is shown in the drawing at the end of its forcing stroke. At the other end of the stroke it is drawn back from the end of the barrel, thus allowing the oil to enter directly from the reservoir. A spring operated ball seat check valve at the end of the plunger barrel prevents the back flow of oil from the lubricator pipe. These valves and the plunger barrels are readily accessible by the removal of special threaded fittings on the front of the lubricator, and the barrels may be renewed.



Location of Force Feed Lubricator on the Locomotive

The oil reservoir contains a small exhaust steam heater of a novel design. Steam from the air pump exhaust passes through a small pipe extending from end to end of the reservoir, the condensation being carried from the lubricator to any convenient point under the engine. Surrounding the steam pipe is a larger pipe with openings to the atmosphere at either end of the reservoir, thus providing for a circulation of air about the steam pipe.



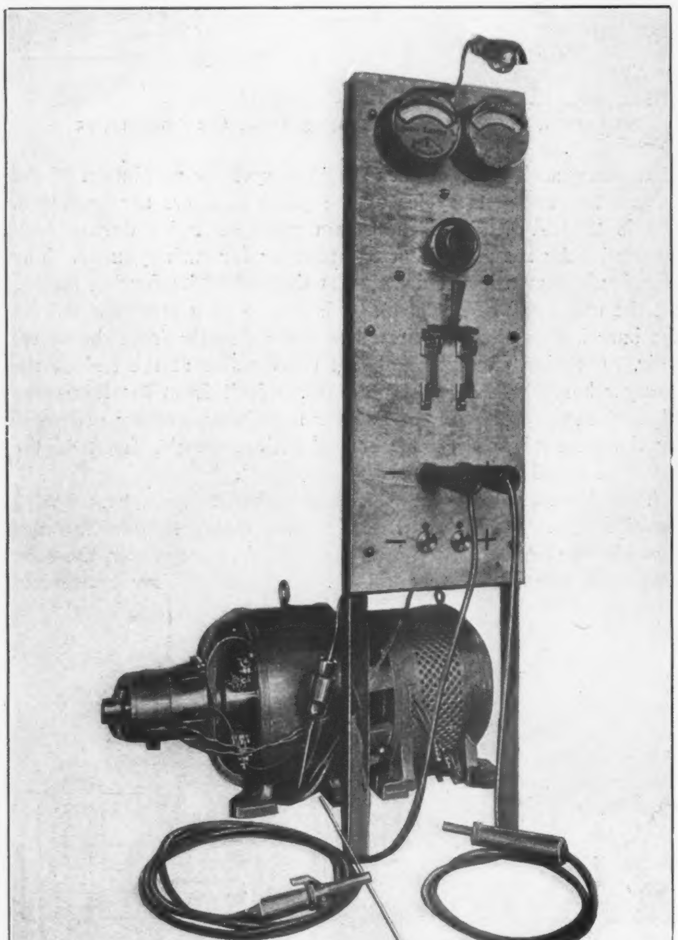
Nathan Force Feed Cylinder Lubricator

The oil in the lubricator reservoir is thus warmed, but without danger of overheating.

CONSTANT CURRENT ELECTRIC WELDER

The electric welding equipment shown herewith has recently been developed by the Lincoln Electric Company, Cleveland, Ohio, with a view to reducing the cost of power consumption and increasing the simplicity of operation. Special windings in the generator, on which patents are pending, automatically regulate the voltage to the exact requirements of the arc, thus providing a predetermined current output which is practically constant irrespective of the varying resistance in the arc.

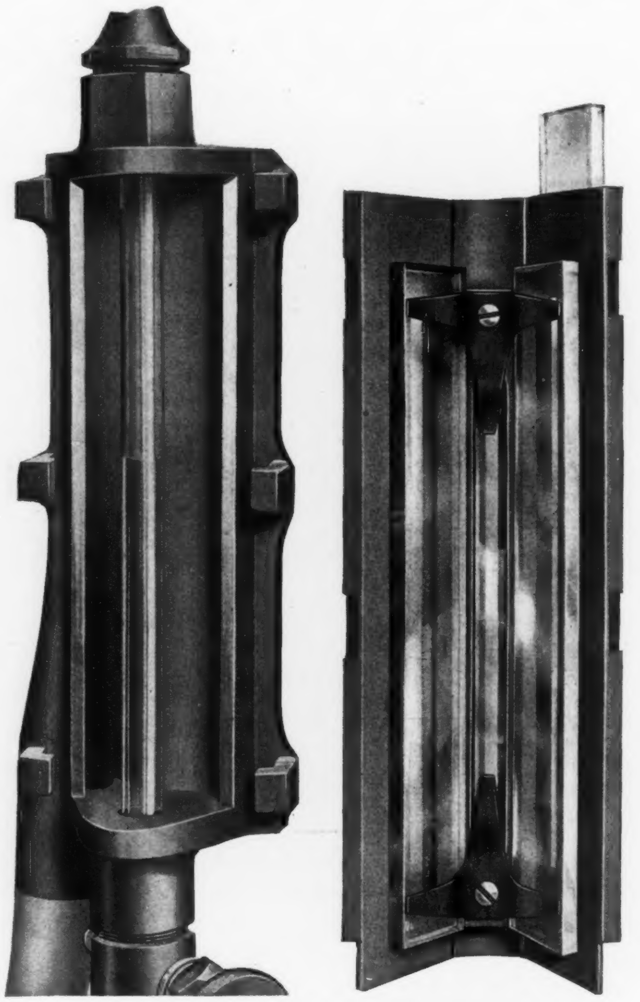
The equipment is built in units, each of sufficient capacity to meet the requirements of one operator. Where more work is done than can be handled by one operator more units are added to the plant. The equipment is thus always operating at practically full capacity and therefore at maximum efficiency, and the investment is closely adjusted to the amount of work to be handled. The automatic voltage regulation greatly reduces the amount of power required; with the exception of work on large steel castings or where heavy cutting is to be done, the equipment may be operated on any power line which will carry a 10 h.p. motor. The equipment is very flexible in operation as any number of units may be operated either individually or in parallel. The operator may, without the services of an electrician, connect three 150-ampere plants in parallel and secure 450 amperes for heavy carbon electrode work and may separate the units again in a few minutes. The positive terminal, shown at the right, is connected to the piece to be welded. On the end of the negative connector is shown the electrode holder with a metal electrode in place.



Lincoln Arc Welder.

WATER GLASS GUARD

Changes have recently been made in the Babcock water glass guard with a view to materially increasing the serviceability of the device by providing for effective illumination of the interior at night. This water glass guard has been in service for some time and the general features of its construction are well known. It consists of two parts: the back, which includes the ends and packing glands, and is provided with an outlet at the bottom for steam and broken glass, and the removable front, which contains the sight glasses. The improvements consist in the redesign of the front casing to include a narrow slot at the apex of the angle between the faces containing the sight glasses. In front of this slot is placed the gage lamp and the light thus admitted thoroughly illuminates the interior of the guard, clearly indicating the water level in the gage glass. This construction eliminates the effect of reflection from the sight glasses which may be very annoying where the light must enter the guard through the sight glasses. This water glass guard is manufactured by the American Car & Ship Hardware Company, New Castle, Pa.



Water Glass Guard with Slot for Illumination.

The Greatest Available Water Power.—Great Falls, Mont., claims the greatest available water power on the continent. There are now operating 75,000 hp., and 100,000 hp. more is being developed. At the lowest average flow of water the available supply is 350,000 hp.

NEWS DEPARTMENT

The shop of the Northern Pacific at Livingston, Mont., is running full time for the first time since 1909.

A fire on August 2 destroyed the storehouse of the Chicago Great Western at Oelwein, Iowa, and most of the contents. The estimated loss is $75,000. Plans are now being prepared for a new structure.

About 150 machinists, boilermakers and sheet metal workers employed by the Kansas City Terminal Railway went on strike last week on account of a controversy with the company regarding the scale of wages and the employment of non-union labor.

On July 19 a car repair shed of the Atchison, Topeka & Santa Fe at Argentine, Kan., was destroyed by fire. There were also 24 cars destroyed and 12 cars damaged. The total estimated loss will not exceed $50,000. The cause of the fire is unknown.

The Canadian Department of Labor has appointed a board under the Industrial Disputes Act to deal with a difference which has arisen between the Canadian Northern and two brotherhoods, those of the locomotive enginemen and the firemen. The men have asked that the conditions under which they work in the East be raised to the level of conditions prevailing on the Western lines.

According to newspaper reports from Seattle, Frank Waterhouse & Co., of that city, have chartered seven vessels to transport 7,500 freight cars to Vladivostok for delivery to the Russian government. Six thousand cars are to be shipped from New York City through the Panama Canal and 1,500 are to be shipped from Puget Sound ports. The average capacity of the vessels chartered is 150 cars for each trip.

The Southern Railway has finished its new coal handling plant at Charleston, S. C., and it will be put in operation September 1. It will have a capacity of 40 cars an hour, which is as fast as any ship now in the coal carrying trade can take it. In preparation for a greatly increased movement of coal to Charleston, the Southern has provided storage room for 400 cars.

On July 1 the Canadian government took over the operation of the Transcona roundhouse and roundhouses, shops, and work pertaining to the motive power department of the Grand Trunk Pacific, between Winnipeg and Westfort, Ont. The supervision of all employees engaged on this section of the road will be in the hands of the Grand Trunk Pacific officers until such time as the government appoints its own staff or takes over the present staff.

The safety bureau of the Union Pacific reports that during the year ending June 30, 1915, the road carried 4,550,949 passengers without a fatality to a passenger. Less than half as many employees of the road were killed during the year as in the fiscal year ending June 30, 1913, which was the last year before the bureau of safety was organized. In 1915 28 employees were killed, as compared with 59 in 1913. In 1915 4,537 employees were injured, and in 1913 6,097 were injured. In 1915 229 passengers were injured, and in 1913 333 passengers were injured.

NEW LOCOMOTIVE INSPECTION RULES

In accordance with the Act of Congress, passed last March, to extend the authority of the Interstate Commerce Commission over the inspection and testing of the entire steam locomotive and tender, rules and instructions have just been formulated by the Division of Locomotive Boiler Inspection. These were considered at a conference with a railroad committee on August 23. The rules are set forth in a 15-page pamphlet and cover ash pans, brake and signal equipment, cabs, warning signals and sanders, draw gear and draft gear, driving gear, lights, running gear, tenders and throttle and reversing gear.

THE MUTUAL MAGAZINE

President Fairfax Harrison, of the Southern Railway, signalized the close of the company's fiscal year by sending to all officeres and employees the following message: "We are closing today a fiscal year which has been full of anxiety and difficulty, but through team work and loyal self-sacrifices and effort by the entire organization, we have come out of it sound and full of courage for the future. This result has not been due to any one man or to any group of men, but to the co-operation of every man who has recognized the problem and given us in our common duty the best that was in him. I send my personal thanks then to everyone of you. The fight is not yet over, but the spirit of the past ten months is bound to see us through. Meanwhile, I want you to know my pride in you and in what has been done already."

PANAMA CANAL 50 YEARS AHEAD OF TIME

"We have recently completed the Panama Canal, a work which it would have been better to have left for 50 years rather than to have put it through with the speed with which the government has done it, because we find that we are not prepared to handle the questions of transportation arising by virtue of the completion of the canal at this time, bearing in mind the fact that the cities in the West, tributary to the coast, east as far as the eastern section of Montana, have a population of only 7,000,000 people. Last year the freight shipments from the Atlantic seaboard to Western territory amounted to 170 train loads, and shipments eastbound about half that amount."—F. R. Hanlon, traffic manager of the port of Seattle, Wash., address before convention of United Yardmasters' Association at Seattle.

MEETINGS AND CONVENTIONS

Chief Interchange Car Inspectors and Car Foremen.—The seventeenth annual convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America will be held at Murphy's hotel, Richmond, Va., September 14-16. This is the first time that the meeting of the association has been held so far south, and it is suggested that this will offer a good opportunity for southern railroad men to attend.

International Association for the Prevention of Smoke.—The tenth annual convention of the International Association for the Prevention of Smoke will be held at Hotel Sinton, Cincinnati, Ohio, September 8, 9 and 10. Of the papers to be presented those which will be of special interest to railroads are the following: Value of Publicity in Smoke Abatement Work and Methods of Obtaining It; Smokeless Locomotive Operation Without Special Apparatus; Various Methods of Eliminating Smoke from Roundhouses in Chicago; How Smokeless

Operation of Locomotives Was Obtained in Washington, D. C.; What the Railroads Have Done to Abate Smoke in Cincinnati, and Enforcing a Smoke Ordinance.

Foundry and Machine Exhibition.—The Foundry and Machine Exhibition will be held on Young's Million Dollar Pier, Atlantic City, from September 25 to October 1. This is the first time in three years that the exhibit has been held in the east, and there will be a keen interest in it in that section particularly. Business conditions in this line are improving everywhere, and the attendance promises to be large and the exhibit a profitable one for the exhibitors. From all indications, therefore, the exhibit should be as successful as the one in Chicago last year. C. E. Hoyt, the secretary, has opened an office in the Bourse, Philadelphia, for the convenience of exhibitors, and others desiring information or help of any kind.

The Traveling Engineers' Association.—The twenty-third annual convention of the Traveling Engineers' Association will be held at the Hotel Sherman, Chicago, commencing at 10 a. m., Tuesday, September 7, and continuing four days. The subjects to be discussed are as follows: "What Effect Does the Mechanical Placing of Fuel in Fireboxes and Lubricating of Locomotives Have on the Cost of Operation?" W. L. Robinson, chairman; "Recommended Practices for the Employment and Training of New Men for Firemen," L. R. Pyle, chairman; "The Advantages of the Use of Superheaters, Brick Arches and Other Modern Appliances on Large Engines, Especially Those of the Mallet Type," J. E. Ingling, chairman; "How Can the Road Foreman of Engines Improve the Handling of the Air Brakes on Our Modern Trains?" C. M. Kidd, chairman; "Difficulties Accompanying Prevention of Dense Black Smoke and its Relation to Cost of Fuel and Locomotive Repairs," Martin Whelan, chairman; "The Electro-Pneumatic Brake," W. V. Turner; "The Effect of Properly Designed Valve Gear on Locomotive Fuel Economy and Operating," W. E. Preston; "Scientific Train Loading, Tonnage Rating, the Best Method to Obtain Maximum Tonnage Haul for the Engine Over the Entire Division, Taking Into Consideration the Grades at Different Points on the Division," O. S. Beyer, Jr.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting of mechanical associations:

AIR BRAKE ASSOCIATION.—F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN RAILROAD MASTER TINNERS, COPPERSMITHS AND PIPEFITTERS' ASSOCIATION.—W. E. Jones, C. & N. W., 3814 Fulton St., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—Owen D. Kinsey, Illinois Central, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Prof. E. Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual meeting, December 7-10, 1915, New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago. Annual meeting, October, 1915.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 North Fiftieth Court, Chicago. Second Monday in month, except July and August, Lytton Building, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMAN'S ASSOCIATION.—S. Skidmore, 946 Richmond St., Cincinnati, Ohio. Annual meeting, September 14-16, 1915, Richmond, Va.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—C. G. Hall, 922 McCormick Building, Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1126 W. Broadway, Winona, Minn.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, Lima, Ohio.

MASTER BOILER MAKERS' ASSOCIATION.—Henry D. Vought, 95 Liberty St., New York.

MASTER CAR BUILDERS' ASSOCIATION.—J. W. Taylor, Karpen Building, Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 14-17, 1915, Detroit, Mich.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—E. Frankenberger, 623 Brisbane Building, Buffalo, N. Y. Meetings monthly.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., East Buffalo, N. Y. Convention, September 7-10, 1915, Hotel Sherman, Chicago, Ill.

PERSONALS

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

J. A. MACRAE, who has been appointed mechanical engineer of the Louisville & Nashville, with headquarters at Louisville, Ky., was educated at the University of Illinois, where he took a course in mechanical engineering, graduating in 1896. The following year he began railway work as a draftsman in the office of the mechanical engineer of the Chicago & North Western, remaining with that company until 1899, when he entered the service of the New York Central & Hudson River. There, until 1904, he was engaged in special work and as draftsman at Albany and at New York City. From 1904 to 1906 he was mechanical engineer of the Boston & Albany, at Boston. Then until January, 1915, he was mechanical engineer of the Michigan Central at Detroit, Mich., and now becomes mechanical engineer of the Louisville & Nashville, with headquarters at Louisville, Ky., as above noted.

J. A. MacRae

SHOP AND ENGINE HOUSE

J. A. MILER has been appointed locomotive foreman of the Grand Trunk Pacific at Endako, B. C., succeeding G. H. Laycock, transferred.

JOHN MCREA, heretofore shop foreman of the Canadian Pacific at Kamloops, B. C., has been appointed locomotive foreman at North Bend, B. C., succeeding C. Brown.

PURCHASING AND STOREKEEPING

R. A. JACOBS has been appointed traveling storekeeper of the St. Louis & San Francisco, succeeding E. J. Price, promoted.

H. M. POWELL, recently general storekeeper of the St. Louis & San Francisco, has been appointed to the newly-created position of supervisor of material and supplies of the Texas & Pacific, with headquarters at Marshall, Tex.

EDWARD J. PRICE has been appointed general storekeeper of the St. Louis & San Francisco, with headquarters at Springfield, Mo., succeeding H. M. Powell. Mr. Price was born at Marion, Ill., on June 28, 1870. He was educated in the common and night schools and entered railway service on September 21, 1888, as messenger boy with the Union Pacific at Kansas City, Mo. He left the Union Pacific in June, 1891, and went to the Atchison, Topeka & Santa Fe, which road he remained with until November, 1913, when he was appointed traveling storekeeper of the St. Louis & San Francisco, from which position he is now promoted, as above noted.

SUPPLY TRADE NOTES

G. F. Riddell, superintendent of the Chicago Heights Works of the Inland Steel Company, died of heart failure at his home in Chicago on August 12.

The Canadian Car & Foundry Company, which has been working on an $83,000,000 order for shells for some time, is now reported to have received an additional order for $71,000,000.

The Keuffel & Esser Company, New York, has been awarded three grand prizes at the Panama-Pacific Exposition at San Francisco, for its exhibit of drawing instruments and slide rules, surveying instruments and telescopic sights and periscopes, respectively.

W. K. Millsapps, southwestern representative of the Grip Nut Company, Chicago, with headquarters at Houston, Tex., died on August 6, at Houston. Prior to his connection with the Grip Nut Company he was for several years general storekeeper of the Sunset Central lines.

Lewis Littlepage Holladay and Henry Negstad, consulting engineers, have formed a company under the corporate name of Holladay, Negstad & Co., and will specialize in the field of power plants, utilities and industries. They will be located at 109 North Dearborn street, Chicago.

Charles B. Ellis, assistant to J. L. Replogle, vice-president and general manager of the American Vanadium Company, with office in New York, has become associated with the Bartlett-Hayward Company, Baltimore. Mr. Ellis was for many years with the Cambria Steel Company.

Thomas Cantley, vice-president of the Nova Scotia Steel & Coal Company, Halifax, N. S., has been elected president of that company, succeeding R. E. Harris, who has resigned to become a member of the Nova Scotia Supreme Court. The vice-presidents of the company now are J. D. McGregor and D. W. Ross.

M. A. Evans, western sales manager of the Railway Appliances Company, Chicago, at the time that company was bought by the Q. & C. Company, New York, and with the latter company temporarily during the reorganization period, has resigned. Mr. Evans will take a short vacation before returning to the railway supply business.

The Spray Manufacturing Company, Boston, Mass., recently incorporated to construct spray cooling systems, gas scrubbers, odor and fume condensers, etc., has changed its name to the American Spray Company, as it will engage in general engineering work involved in the use of spray systems. The management of the company remains unchanged.

Robert M. Smith, assistant mechanical engineer of the Acme Supply Company, Chicago, has been appointed mechanical engineer. Mr. Smith was formerly chief car draftsman for the Illinois Central and went to the Acme Supply Company last January as inspector. In March he was appointed assistant mechanical engineer, and on August 1 mechanical engineer.

The Pratt & Whitney Company has opened an office and showroom at 16 Fremont street, San Francisco, in charge of S. G. Eastman, formerly manager of the Chicago office. A large stock of Pratt & Whitney machinery, small tools and gages will be carried for the convenience of customers, and the office has been appointed agent for the entire Niles-Bement-Pond line of machine tools, cranes, steam hammers, etc.

The Mesta Machine Company, Pittsburgh, Pa., has recently received an order from James B. Ladd, consulting engineer, Philadelphia, for a 1,500 hp. mill engine for the Broken Hill Proprietaries Company, Ltd., New Castle, N. S. W. The engine is for rolling mill service, and is to be of the heavy-duty tandem compound Corliss valve type. This engine, when installed, will make the fourth unit that the Mesta Machine Company has built for the Broken Hill Proprietaries Company.

Joseph T. Ryerson & Son, Chicago, have recently completed a new warehouse on Westside avenue, Jersey City, N. J. The company has maintained an office at 30 Church street, New York, and a warehouse at Boonton for some time. The new plant in Jersey City will put it in a much stronger position for handling its iron, steel and machinery business in the New York district and the East in general. The warehouse is located on a ten-acre site at the junction of the Hackensack river and Newark bay, thus affording facilities for making water shipments to all parts of New York harbor and adjacent waters. The building is 350 ft. by 250 ft., and covers a ground area of 87,500 sq. ft.

The Bethlehem Steel Company has purchased the plant of the Detrick & Harvey Machine Company, Baltimore, Md. The directors of the latter have elected the following officers: A. D. Mixsell, president; W. F. Roberts, vice-president; J. W. Neidhardt, vice-president and general manager; B. F. Jones, secretary and treasurer, and F. A. Shick, auditor. Mr. Neidhardt, as vice-president and general manager, will be the local representative of the Detrick & Harvey Company, at Baltimore. This company was formed in 1884 by John S. Detrick and Alexander Harvey, and these two occupied the positions of president and secretary and treasurer, respectively, until Mr. Harvey's death last November, when Curran W. Harvey, his son, succeeded his father. The company manufactures planers, horizontal drilling and boring machines, vertical boring and turning mills and special machinery. It will continue to engage in this business.

Bertram Smith, who has been in the storage battery business for the past 15 years, has been appointed manager of the Detroit office of the Edison Storage Battery Company, Orange, N. J. About a year and a half ago Mr. Smith became assistant manager of the Edison Storage Battery Supply Company, of San Francisco, Cal., the distributor for the Edison Nickel-Iron-Alkaline Battery on the Pacific Coast. Directly previous to his connection with the Edison Company he was manager of the battery department in the Chicago branch of the United States Light & Heating Co. He was formerly secretary and treasurer of the National Battery Company, of Buffalo, until its consolidation with the United States Light & Heating Co.

Edward A. Everett, formerly signal engineer of the Michigan Central, has opened an office at 50 Church street, New York, for the sale of railway supplies and signal material. He represents the Hobart-Allfree Company, Chicago, derailers and car replacers; E. J. Clark, Philadelphia, Pa., T. C. Cypress Trunking and Capping; the National Concrete Machinery Company, Madison, Wis., concrete fence post machinery and supplies; the Detroit Twist Drill Company, Detroit, Mich., high-speed bonding drills; the J. Frederick Schroeder Air Felt Company, Newark, N. J., high-grade air felt used in refrigerator car construction, steam pipe covering and as a cushion under relays and electrical apparatus; the Cincinnati Electrical Tool Company, Cincinnati, Ohio, portable electric drills, grinders and reamers; the Keller Pneumatic Tool Company, pneumatic drills, hammers, riveters and chippers; the Reliable Electric Company, Chicago, signal, telephone and telegraph specialties. Mr. Everett also has charge of the sales of the electric release train annunciator, which is one of his patents and which has been sold for several years by the Railroad Supply Company, Chicago. He also has a line of copper clad and bond wires and high strength non-corrosive bond wire.

CATALOGS

Pipe Accessories.—The William Powell Company, Cincinnati, Ohio, has issued a booklet relative to the company's line of oil and air vents, expansion joints, valves and other accessories for oil wells and refineries.

Sand Dryers.—The Roberts & Schaefer Company, Chicago, has issued Bulletin No. 30, illustrating and describing the "Beamer" patent steam sand dryer, made by that company for drying sand for locomotive use.

Power Transmission Machinery.—The Mesta Machine Company, Pittsburgh, Pa., has issued Bulletin Ka, containing a horse-power chart for determining the variables for rotating parts transmitting power, such as gears, pulleys, rope wheels, etc.

Power Hammers.—Beaudry & Co., Boston, Mass., have recently issued a booklet relative to the Beaudry Champion and Peerless power hammers, respectively. The booklet describes the hammers in detail and contains tables of sizes and dimensions.

Ball Bearings.—The S. K. F. Ball Bearing Company, New York, has recently issued a very attractive booklet relative to the economies of the light car in electric street railway service and the saving to be obtained by the use of ball-bearing journals on such cars.

Vertical Oil Engines.—This is the title of Bulletin No. 501 recently issued by the National Transit Company, department of machinery, Oil City, Pa. The booklet deals particularly with the type VT-13, two-cycle, single cylinder, vertical oil engines made by this company and contains detailed descriptions of the machine itself and its parts.

Spark Arrester.—Mudge & Co., Chicago, Ill., have recently issued a folder describing the advantages of the Mudge-Slater Front End Spark Arrester, calling attention to its many advantages over the usual form of front-end arrangement, stating that the fire loss on one road equipped with this device has been reduced from $100,000 to about $15,000 a year.

Unions.—The Jefferson Union Company, Lexington, Mass., has issued a catalogue describing the Jefferson unions of various types. The booklet contains views of the different kinds of unions and shows for what purposes they are made. The patented feature of this company's product is the brass seat ring, placed in a recess away from the runway of the fitting.

Sand-Blast Apparatus.—The Mott Sand Blast Manufacturing Company, New York, has issued four folders dealing with the following sand-blast apparatus which it manufactures: The Mott direct pressure sand-blast machine, hose type; the Mott sand-blast tumbling barrel, revolving table and cabinet, type G; the Mott type P.V.S. double sand-blast tumbling barrel, and Mott sand-blast accessories.

Centrifugal Pumps.—Catalogue H-2, recently issued by the Lea-Courtenay Company, Newark, N. J., describes and illustrates the various types and sizes of Lea-Courtenay centrifugal pumps. The booklet, containing 64 pages, is divided into 12 chapters, dealing, respectively, with the care taken in the manufacture of this company's product and the characteristics of the pumps. The booklet is profusely illustrated.

National Pipe.—Bulletin No. 20, recently issued by the National Tube Company, Pittsburgh, Pa., is an index to Bulletins Nos. 1 to 20 which have been issued by this company. The bulletin represents an index of considerable detail, the idea being to offer pipe information readily accessible to the reader. The last two pages of the bulletin give a detailed list of the bulletins to which reference is made.

Boro-Carbone.—The Abrasive Material Company, Philadelphia, Pa., has recently issued a pamphlet describing the Boro-Carbone, which is a new type of abrasive recently placed on the market. This material is oxide of alumina, produced in crystalline formation in an electric furnace. The pamphlet contains a description of this abrasive, the various forms produced by the company being illustrated. Various other information of interest to handlers of grinding wheels is also included.

Locomotives for Plantation Service.—Record No. 80, recently issued by the Baldwin Locomotive Works, is devoted to the subject of locomotives for plantation service. In the booklet there are shown 29 different designs of locomotives suitable for this kind of work. These vary in type and capacity from light, four-coupled engines, suitable for switching service and short hauls, to large engines of the Consolidation type, which are qualified for road service. Information is given covering the hauling capacity of each locomotive illustrated, as well as the other principal general dimensions.

Safety Code for Abrasive Wheels.—The Abrasive Material Company, Philadelphia, Pa., has recently issued a pamphlet containing the safety code for the use and care of abrasive wheels and the parts of grinding machines related thereto, which has been approved by a number of the abrasive wheel manufacturers. The code is divided into five sections dealing with protection flanges, protection hoods, cups, cylinders and sectional ring wheels, general safety requirements and precautionary suggestions. There is also included in the pamphlet a table of the causes of grinding-wheel accidents, reprinted from Grinding Wheels.

Results of Electrification.—This is the title of Circular No. 1505, which has recently been issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This so-called circular is a book 9 in. by 11 in. in size, containing 72 well-illustrated pages. It aims to show the results obtained by electrification on some of the important steam railways of the world and to give information of interest and value to steam railroad operators on electrification work. Contained in the publication are well-illustrated descriptions of the Norfolk & Western, the Pennsylvania, the New Haven and other electrifications installed by the Westinghouse company. The Westinghouse Electric & Manufacturing Company has also recently issued the first number of "Westinghouse Electrification Data," which is to be a periodical to chronicle the latest advances in the field of heavy traction. The present number contains a discussion of electric locomotive characteristics, some interesting figures on the comparative maintenance costs of steam and electric locomotives, as well as data on the New York terminal electrification of the Pennsylvania.

Centrifugal Air Compressors.—The De Laval Steam Turbine Company, Trenton, N. J., has recently issued a 64-page book dealing with centrifugal blowers and compressors for all pressures from 5 in. of water, as in mechanical draft service, up to 125 lb. per sq. in., as for compressed air distribution in mines, machine shops, shipyards, etc. The development of the high efficiency, high speed centrifugal blower or compressor has depended upon improvements in materials, construction, shop practice and design such as are employed in the building of high-grade steam turbines. In the present publication numerous charts are given showing curves for the isothermal, adiabatic and actual compression of air, also the theoretical power required to compress air and characteristic curves of single and multi-stage blowers and compressors. The influence of impeller design upon the form of the characteristic is discussed at some length. Particulars are given concerning the application of centrifugal blowers and compressors to forced draft, coal gas manufacture, coke oven plants and water-gas plants, sugar factories, cupola and blast furnace work, Bessemer converters, supplying compressed air in mines, shipyards, etc. The illustrations present numerous examples of blowers and compressors directly connected to steam turbines and to electric motors.